OCTOBER, 1941.

GENERAL PHYSICS.

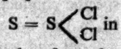
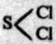
ATOMIC AND MOLECULAR STRUCTURE.

1936. The isotopic constitution of lead and the measurement of geological time. III. A. O. NIER, R. W. THOMPSON AND B. F. MURPHEY. *Phys. Rev.*, **60**, *pp.* 112–116, *July* 15, 1941.—A mass-spectrographic measurement of the relative abundances of the isotopes in 8 samples of radiogenic Pb and 13 samples of common Pb has been made. As 5 of the radiogenic Pb samples originated from minerals containing both U and Th, 3 independent determinations of the age could be made. One of the samples was the oldest so far studied and appears to have an age close to 2×10^9 years. The common Pb samples were found to have large variations in the relative abundances of the same sort as were reported in a previous investigation of 12 other samples. [See Abstr. 1090 (1939), 5151 (1937)]. AUTHORS.

1937. On the electron diffraction of multi-layers of esters of fatty acids. I. A. CAMERON AND G. D. COUMOULOS. *Proc. Roy. Soc. A*, **178**, *pp.* 415–420, *Aug.* 15, 1941.—The arrangement of the long axis of the long-chain organic molecules is revealed by electron diffraction patterns of inclined specimens. The side spacings are estimated from a composite pattern of kaolin which has a known standard structure and lattice constants. A 3 cm. vacuum valve was designed to isolate the apparatus from the oil-diffusion pumps. AUTHORS.

1938. On the electron diffraction of multi-layers of esters of fatty acids. II. The structure of multi-layers of the esters. G. D. COUMOULOS AND E. K. RIDEAL. *Proc. Roy. Soc. A*, **178**, *pp.* 421–428, *Aug.* 15, 1941.—Electron-diffraction data for the arrangement and the orientation of the molecules and the side spacings of the 2-dimensional crystals of thin multi-layers of methyl and ethyl stearate, and octadecyl acetate, are given. A state similar to the α-modification in crystals is a stable form for thin multi-layers of long-chain esters. The multi-layer state is transient and is replaced by an aggregation of micro-crystals with fibre orientation. AUTHORS.

1939. Critical and co-operative phenomena. VI. The neighbour distribution function in monatomic liquids and dense gases. J. CORNER AND J. E. LENNARD-JONES. *Proc. Roy. Soc. A*, **178**, *pp.* 401–414, *Aug.* 15, 1941.—A formula is given for the neighbour distribution function in liquids and dense gases, assuming that each atom is vibrating in the field of its neighbours when in their equilibrium positions. It is shown that a parabolic potential leads to a simple result. Applying this to K, a structure is found which bears some resemblance to a body-centred cubic. Finally it is shown how interatomic fields may be derived from the distribution function of a single shell of neighbours, when this has been determined from experiment. AUTHORS.

1940. Magnetism and molecular structure of sulphur compounds. S. S. DHARMATTI. *Proc. Indian Acad. Sci. A*, **13**, *pp.* 359–370, *May*, 1941.—The susceptibilities of a number of S compounds have been calculated by Slater's and Angus's methods and compared with experimental values. The molecular structures of the compounds can thus be arrived at or confirmed. S_2Cl_2 is shown to have the unsymmetrical formula  $S{=}S{<}^{Cl}_{Cl}$ in agreement with the structure arrived at from the Raman effect. S_2I_2 also has the unsymmetrical structure. SCl_2 can only have the constitution  $S{<}^{Cl}_{Cl}$ which is confirmed. O in $SOCl_2$ is probably paramagnetic. A. J. M.

1941. Bond lengths and resonance in the *cis*-azobenzene molecule. G. C. HAMPSON AND J. M. ROBERTSON. *J. Chem. Soc.*, *pp.* 409–413, *July*, 1941.—Refinements have been made in the determination of the crystal structure of *cis*-azobenzene, by applying the Fourier series method of analysis. Steric effects prevent the molecule from being coplanar, the 2 benzene rings being rotated so that the distance between the *o–o'* carbon atoms is 3·34 Å. This departure from coplanarity leads to a suppression of the resonance, as is shown by the values found for the N–N and C–N distances. The analysis also indicates a slight distortion of the molecule, so that the C–N bonds are not quite directed from the centres of the benzene rings, this slight distortion also no doubt being due to steric repulsion. AUTHORS.

1942. Force constants of some C–C bonds. J. W. LINNETT. *Trans. Faraday Soc.*, **37**, *pp.* 469–473, *Sept.*, 1941.—The 25 fundamental vibration frequencies of the 2 methyl acetylenes have been calculated, using a potential function involving 11 constants. The values obtained for the force constant of the C–C single bond in these molecules and for that in methyl cyanide are discussed and compared with the values given by Crawford and Brinkley [Abstr. 437 (1941)]. AUTHOR.

1943. Note on nuclear radii. R. D. PRESENT. *Phys. Rev.*, **60**, *pp.* 28–31, *July* 1, 1941.—Corrections to the nuclear radius and particle density arising from the neutron excess $N-Z$, from the electrostatic repulsion of the protons and from the surface-tension forces, are calculated on the basis of the statistical model. The density throughout the interior of the heaviest nuclei is found to be about $\frac{1}{3}$ less than in medium light nuclei ($A \sim 50$). The trend of $r_0 = R/A^{1/3}$ from the lightest to the heaviest elements is discussed and compared with experiment. AUTHOR.

See also Abstract 2055.

COLLOIDS.

1944. Studies in electrokinetics. XXV. The electroviscous effect. II. In systems of Ca and Na caseinates. C. L. HANKINSON AND D. R. BRIGGS. *J. Phys. Chem.*, **45**, *pp.* 943–953, *June*, 1941.—Experimental data are presented for measurements of electrokinetic potentials (ζ), specific conductivities (λ) and relative viscosities (η_s/η_0) on systems of both Ca and Na caseinate, without and with the addition of small amounts of the chloride of the cation common to the colloid. These data, when calculated and plotted as variables in the linear form of the electroviscous equation, fall on a straight line, in agreement with previous results on sodium gum arabic systems [Abstr. 1395 (1941)]. The electroviscosity accounts for 59% of the sp. viscosity in a 1% Ca caseinate system and for only 38% in a 1% Na caseinate system. The numerical values of the slopes of the straight lines obtained from the electroviscosity data increase linearly with increasing colloid concentration, indicating that the calculated value of the radius of the micelle decreases with increasing colloid concentration. H. H. Ho.

1945. Abnormal series of colloidal solutions produced by electrolytes. III. Investigation of HgS-sols from different initial materials. N. SATA AND K. MÔRI. *Bull. Chem. Soc., Japan*, **16**, *pp.* 139–143, *May*, 1941. *In German.*—Previous work [Abstr. 415 (1938), 3058 (1940)] is continued and it is now found that all HgS-sols which have been prepared from $Hg(CN)_2$, $HgSO_4$ and $Hg(NO_3)_2$, as initial materials always possess abnormalities. It was also determined that foreign substances mixed with the sol (such as ions) had no appreciable effect on the phenomena. The abnormal properties which are characteristic of the sol are not therefore to be regarded as electrical effects due to the absorption of polyvalent ions. H. H. Ho.

1946. Role of cystine in the structure of the fibrous protein, wool. W. I. PATTERSON, W. B. GEIGER, L. R. MIZELL AND M. HARRIS. *Bur. Stand. J. Res. Wash.*, **27**, *pp.* 89–103, *July*, 1941.—A number of the important physical and chemical properties of wool are closely associated with the presence of disulphide cross-linkages between the polypeptide chains of the protein. This conclusion results from a study of the behaviour of wool before and after alteration of the mode of linkage of the sulphur by a series of highly specific reactions. It is shown that wool can be reduced with thioglycolic acid over a wide range of *p*H, and that, when the reduction is carried out in neutral or acid solution, the fibrous structure of the wool is not destroyed when the disulphide groups are reduced to sulphhydryl groups. Thus reaction of reduced wool with alkyl monohalides results in permanent rupture of disulphide linkages, and the fibres are greatly increased in extensibility and decreased in strength. Alkylation with aliphatic dihalides introduces hydrocarbon chains between pairs of S atoms of cystine molecules in the fibres. Such fibres are very similar to untreated fibres in physical properties. Wool in which the disulphide linkages have been broken by reduction, or by reduction and alkylation with alkyl monohalides, possesses much higher alkali-solubility than untreated wool, while wool in which the disulphide cross-linkages have been replaced by new covalent cross-linkages through reduction followed by alkylation with dihalides possesses much lower alkali-solubility. Since the susceptibility of wool to degradation by alkalies is one of its greatest disadvantages, processes that would make it stable toward alkalies should also enhance its durability. AUTHORS.

1947. Note on Halley's formula for sedimentation equilibrium. F. CERNUSCHI. *Rev. Univ. nac. Tucumán A*, **1**, 1 *and* 2, *pp.* 267–269, 1940. *In Spanish.*—The author introduces a correction term, accounting for interaction between particles, into the expression for the variation of density with height in a gravitational field according to Maxwell-Boltzmann. This leads to a critical state for colloids below 200°K., still awaiting experimental confirmation. ED.

***1948. Pendulum method for measuring settling velocities.** J. H. MCMILLEN, L. F. STUTZMAN AND J. E. HEDRICK. *Industr. Engng Chem.* (*Analytical Edition*), **13**, *pp.* 475–478, *July* 15, 1941.—In the method described, suitable for opaque suspensions, the liquid is contained in a long tube arranged to swing like a pendulum from 2 separate sets of supports in turn. From the change in the period of oscillation the rate of lowering of the c.g. can be calculated. Assuming also equal velocity of fall for all the particles, and that this velocity is constant with time, the rate of settling of the actual particles can be found. Mathematical expressions for the processes are developed. N. M. B.

***1949. Automatic speed control for the air-driven ultra-centrifuge.** A. Rothen. *Rev. Sci. Instrum.*, **12,** *pp.* 355–357, *July*, 1941.—The pressure of the air driving the centrifuge is automatically decreased or increased according as the centrifuge tends to accelerate or decelerate. The speed of the centrifuge can be maintained constant within less than 1 rev./sec. Author.

CRYSTAL STRUCTURE AND SPECIAL PROPERTIES.

1950. On the presentation of crystal chemistry. A. F. Wells *Phil. Mag.*, **32,** *pp.* 106–136, *Aug.*, 1941.—The presentation of systematic crystal chemistry demands a classification of crystal structures. It is suggested that the most satisfactory classification for this purpose is one which is primarily geometrical and based as far as possible on observed interatomic distances. A classification of this kind is described. Appendices are devoted to critical reviews of (1) the classification of structures according to bond type, and (2) the sub-division of ionic structures according to electrostatic bond strength. Author.

1951. Accurate evaluation of lattice spacings from back-reflection powder photographs. S. S. Lu and Y. L. Chang. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 517–528, *Sept.*, 1941.—By considering all the possible systematic errors in the determination of lattice spacings by the back-reflection camera, methods have been devised for their correction. For cubic crystals, if the observed values of lattice spacing are plotted against $\cos\phi$, where ϕ is the supplement of the angle of deviation, a straight line will be obtained. The extrapolation to $\cos\phi = 1$ will give the correct value of the lattice constant. For non-cubic crystals an analytical method is to be preferred. The systematic errors will make $\cos^2(\phi/2)$ inaccurate by an amount proportional to $\sin^2\phi$, which may thus be introduced as a correction term to the Bragg equation in the quadratic form. Examples of the determination of the lattice spacings of some very pure metals are given. The accuracy attained is about 1 : 50000. Authors.

1952. Structure of black carbon. A. H. White and L. H. Germer. *J. Chem. Phys.*, **9,** *pp.* 492–497, *July*, 1941.—This paper is concerned with the structure of extremely small crystallites of C deposited upon Si by the pyrolysis of CH_4. Electron diffraction patterns have been obtained from more than 100 carbon films, from some by the reflection method and from others by transmission after removing the films from their supports with HF. In some of the specimens the individual crystallites are strongly oriented and reflection patterns obtained from these are approximations to rotation patterns from single crystals. From these patterns it is concluded that the films are made up of pseudo-crystals, in each of which the C atoms are hexagonally arranged in planes, as in graphite, but successive parallel atomic layers are displaced so that no regularities exist other than the uniform separation of the planes and the regular arrangement of atoms in each of them. Authors.

1953. Study of the growth of chemical compounds on a Cu single crystal by the method of electron diffraction. I. H. Usmani. *Phil. Mag.*, **32,** *pp.* 89–105, *Aug.*, 1941.—Thin films of CuI, CuBr, Cu_2S and Cu_2O, have been formed electrolytically on an etched surface of a single crystal of copper. It is shown, by diffracting electrons from the surfaces of these films, that they grow as single crystals when deposited at small current densities, revealing a definite orientation relationship to the Cu crystal base. All of them have their most densely packed (111) planes parallel to the (111) plane of Cu. The Cu_2O film shows spots forbidden by the structure factor, which are attributed to a second diffraction of the primary beam. CuI, CuBr and Cu_2S films, show additional spots in the $\overline{1}10$ azimuth due to spinel twinning, (111) being the twin plane. CuS film formed electrolytically has a structure which does not agree with the structure of either Cu_2S or CuS as given by X-rays. Instead, it shows cubic symmetry with a unit cell of edge 4·058 Å. CuS films formed by the direct action of H_2S gas on Cu crystal show no single crystal formation in reflection patterns; transmission of electrons through such films when stripped, however, show a spot pattern with hexagonal symmetry—again having a structure different from that given by X-rays. The two sulphides, one formed electrolytically and the other by dry H_2S gas, had 2 different structures. Author.

See also Abstracts 1941, 1959, 2107.

DENSITY.

See Abstracts 1977, 2089.

DIFFUSION AND OSMOSIS.

1954. Thermal diffusion in hydrogen-deuterium mixtures. K. E. Grew. *Proc. Roy. Soc. A*, **178,** *pp.* 390–399, *July* 31, 1941.—The separation produced by thermal diffusion in hydrogen-deuterium mixtures has been measured at temperatures between − 183° and 425°C. and the thermal diffusion ratio R_T found. Theoretical values of R_T for the same mixture have been calculated for various values of the force index ν from Chapman's general expression appropriate to molecules behaving as point centres of repulsive force $F = \kappa r^{-\nu}$. The evaluation of R_T in this way is possible only for isotopic mixtures, in which the interactions between like and between unlike molecules are the same. Comparison of the experimental value of R_T with these theoretical values indicates that the fields of the hydrogen and deuterium molecules have an index $\nu = 12{\cdot}6$. This agrees with the value $\nu = 12{\cdot}5$ deduced from viscosity results. It is higher than the value $\nu = 8{\cdot}6$, which is found if the theoretical values of R_T for a Lorentz gas are assumed to apply—an assumption necessarily made in the case of the non-isotopic mixtures examined so far. This result suggests that the discrepancies between values of ν hitherto deduced from thermal diffusion measurements and those expected from viscosity values are attributable to this assumption. The calculation shows that R_T depends slightly on the concentration of the mixture, a point on which the experimental evidence is inconclusive. AUTHOR.

1955. Diffusion and thermal diffusion of hydrogen-deuterium, with a note on the thermal diffusion of H-He. H. R. HEATH, T. L. IBBS AND N. E. WILD. *Proc. Roy. Soc. A*, **178**, *pp.* 380–389, *July* 31, 1941. —The diffusion coefficient has been determined for hydrogen-deuterium and is found to be in close agreement with the value predicted by the classical theory. The case is one of particular interest because the diffusing molecules have the same size and the same molecular field. The thermal separation in mixtures of this pair of gases has also been measured. As the molecules are of the same size, the thermal separation is due entirely to difference in mass. By using Chapman's theory, the value of the repulsive force index is deduced. By combining these data the repulsive force constant can be determined, and so the complete law of force operating in collisions between unlike molecules can be obtained. On classical considerations this law of force would apply to either gas separately. Measurements of thermal separation in mixtures of H and He have also been made. It is shown that this pair of molecules is "harder" than hydrogen-deuterium. Comparison is made with earlier results of Elliott and Masson. AUTHORS.

***1956. Simple apparatus for measuring diffusion of gases through foils. (Diffusion of gases through highly polymerized matter. I.)** F. H. MÜLLER. *Phys. Z.*, **42**, *pp.* 48–53, *Feb.* 15, 1941. *In German.* —The manometric principle is employed for rapid measurement. Two designs are described with the aid of diagrams, the one for condensing and the other for non-condensing gases, and the method of making measurements with them is detailed. Results are compared in a table with the values obtained by other methods and show good agreement. The descriptive matter is preceded by the derivation from the differential equation of diffusion of a formula for determining the dimensions of apparatus for diffusion measurements through foils. H. G. S.

***1957. Instrument for measuring the rate of penetration of oil and other liquids into paper.** A. C. POULTER. *J. Sci. Instrum.*, **18**, *pp.* 188–190, *Sept.*, 1941.—The rate of penetration of oil into paper is assessed from the decrease in opacity as oil penetrates into the sheet. This is measured photo-electrically and the design of a suitable instrument is described. The sheet is illuminated on the underside with diffuse light and that transmitted is measured on a photo-electric cell immediately above. The derivation of the formulae for the rate of penetration and depth penetrated at any time after oiling is given, as well as curves showing typical results. AUTHOR.

ELASTICITY AND PLASTICITY.

1958. The theory of the plastic properties of solids. IV. F. SEITZ AND T. A. READ. *J. Appl. Phys.*, **12**, *pp.* 538–554, *July*, 1941.—This is a continuation of an earlier paper [Abstr. 1139 (1941)] and deals with the properties of polycrystalline materials which may be deduced from the characteristics of single crystals. The physical properties of the boundary material are found to be slightly different from those of the bulk material, but the boundary material has a high bond strength at temperatures not too near the m.p., and transcrystalline cracking frequently occurs, although rupture frequently starts at a boundary. The stress needed to produce a given deformation is smaller for cubic crystals, such as Al having 4 equivalent planes of easy slip, than for hexagonal crystals, such as Zn having only 1 plane of easy slip. The stress/strain curve of a polycrystalline material composed of randomly oriented grains may be deduced from that of single crystals on the assumption that (*a*) strain is uniform in all grains of the material and (*b*) deformation occurs in each grain by slip on the octahedral plane such that the energy required is a min. Good agreement was found between the measured and computed curves in some experiments, but other work has thrown doubt on the two assumptions. Each crystallographic plane of a single crystal possesses a characteristic tension stress at which rupture occurs, and this stress is thought to be independent of the previous deformation, so that the rupture stress of a polycrystalline material should be independent of the deformation, provided it does not provide widely different orientations, an expectation shown to be supported by tests on wires of pure Cu. A. C. W.

1959. Theory of Rayleigh seismic waves in crystalline media of the cubic system. G. Garcia. *Publ. Fac. Cienc. Fis.-Mat., La Plata*, **11**, *pp.* 49–62, *April*, 1941. *In Spanish.*—A mathematical investigation of the conditions for the existence of Rayleigh waves in crystals of the cubic system, with special reference to NaCl. Ed.

1960. Effect of shape on the bursting strength of tubes. W. M. Hampton. *J. Soc. Glass Technol.*, **25**, *pp.* 121–135, *April*, 1941.—Formulae are given for the stress developed by internal pressure in elliptical and rectangular glass tubes and in 2 cross-sections with rounded corners. The effects of large wall thickness and of an eccentric bore are stated in comparative terms, and examples are given of the use of the formulae in reducing bursting-pressure data. Author.

1961. Fibrous surface texture at fractures. H. Wallner. *Z. Phys.*, **114**, 5–6, *pp.* 368–378, 1939. *In German.*—By means of fracture tests on glass rods 6 to 6·5 mm. in dia. and 12 cm. in length the author quantitatively investigates the surface texture which occurs at fractures, which was first identified by Smekal. Theoretical considerations, confirmed by the tests, show that the texture is due to the combined effect of the primary fracture process and the disturbing elastic waves and that the speed of fracture is less than that of propagation of the disturbing waves. H. G. S.

1962. Supersonic dispersion and speed of fracture. A. Smekal. *Phys. Z.*, **41**, *pp.* 475–480, *Oct.* 15, 1940. *In German.*—Supersonic dispersion regions in solids correlated with faulty structure are discussed. Inorganic glasses best fulfil the conditions, and their dispersion frequencies are estimated to be of the order of 10^{11}/sec., while for salt crystals they are from 5×10^{8}/sec. These frequency regions, although so far unrealizable technically, are shown to play a decisive rôle in the phenomena of fracture propagation in brittle solids. The speed of fracture must thus be less than the speed of normal elastic waves and its magnitude and regularity must depend on the volume density and nature of the cavities in the solid body as well as on their regularity and distribution. Agreement of these deductions from fracture theory with experimental results [Abstr. 667 (1938)] is shown, an agreement which can be extended to secondary fractures arising from fracture processes. Whether secondary fractures are also produced by supersonic waves remains an open question. Finally, it is shown that fracture processes in inorganic glasses can cause secondary supersonic waves in addition to secondary fractures, and so give rise to fracture lines [Abstr. 1961 (1941)], the supersonic waves being of the order of 10^{10}/sec. and thus closely approaching the supersonic dispersion frequency region. H. G. S.

HYDRODYNAMICS AND AERODYNAMICS.

1963. Subsonic flow of a compressible fluid past a circular cylinder between parallel walls. H. Suzuki. *Proc. Phys.-Math. Soc., Japan*, **23**, *pp.* 336–346, *April*, 1941.—Tsien's method is applied to the problem of flow of a fluid past an object between parallel walls. The results of the author's calculations of velocity distribution are compared with those of other workers. It is concluded that the discrepancy between theory and experiment is due to wall effects. The wall effect on the critical Mach number was also calculated. G. E. A.

1964. Flow of saturated water through throttling orifices. M. W. Benjamin and J. G. Miller. *Trans. Amer. Soc. Mech. Engrs*, **63**, *pp.* 419–426; *Disc.*, 427–429, *Aug.*, 1941.—Results of tests on flow characteristics of saturated water and various mixtures of saturated water and steam through sharp-edged thin-plate orifices are given. The actual flow of saturated water through these orifices is considerably greater than would be expected from theoretical calculation based upon a change of state and no critical back-pressure condition is evident over the range of initial pressures considered. The tests have provided sufficient information to permit the derivation of practical design formulae, which have been used successfully in several instances. An Appendix shows the application of the formulae to the design of a single-stage orifice to drain the condensate from a feedwater heater, and to the design of an orifice to be used in series with a float-operated drainer. Authors.

1965. Effect of ambient temperatures on the coefficients of Venturi meters. W. S. Pardoe. *Trans. Amer. Soc. Mech. Engrs*, **63**, *pp.* 457–459; *Disc.*, 459–463, *July*, 1941.

1966. Stability of walls. H. Straub. *Schweiz. Bauztg*, **117**, *p.* 91, *March* 1, 1941. *In German.*—The effect of water pressure acting in tension-cracks on the stability of walls is investigated. W. A. R.

KINETIC THEORY OF MATTER.

1967. Quenching and depolarization of resonance radiation by collisions with molecules of a foreign gas. A. Ellett, L. O. Olsen and R. Petersen. *Phys. Rev.*, **60**, *pp.* 107–111, *July* 15, 1941.—A semi-classical theory describing the quenching and depolarization of resonance radiation by collision with foreign gas molecules is presented. The total depolarizing probability is divided into 2 parts to allow for adiabatic and non-adiabatic depolarization. The equations for polarization are generalized in order to apply to the case in which the observed polarization results from several lines belonging to a hyperfine group. The effect of a magnetic field applied along the direction of observation is also included in the treatment. Experimental results on the polarization of the λ2 537 Å Hg line as a function of gas pressure and as a function of magnetic field at various fixed gas pressures show good agreement with the theory. Cross-sections for quenching and depolarization have been calculated for the gases investigated. AUTHORS.

1968. Helium repulsive potential from collision cross-section measurements. I. AMDUR AND H. PEARLMAN. *J. Chem. Phys.*, **9**, *pp.* 503–506, *July*, 1941.—Total collision cross-sections have been measured for fast He atoms, having velocities corresponding to 300–1 000 eV, scattered in room-temperature He gas. Exponential type potentials account for the experimental results. For the distances involved in the scattering experiments the specific repulsive potential which predicted total collision cross-sections within the experimental error was $V(r) = 11{\cdot}3 \exp(-4{\cdot}63r^{\frac{1}{2}}) \times 10^{-10}$ erg. [See Abstr. 625 (1940)]. AUTHORS.

See also Abstract 1947.

LENGTH, AREA AND VOLUME.

1969. Range-finding. E. LAU. *Phys. Z.*, **41**, *pp.* 544–546, *Dec.* 15, 1940. *In German.*—The determination of the distance of an observer from gratings, placed one behind the other, by the number or direction of the superposed strips produced forms the subject of the paper. These superposed strips lie at infinity in the case of parallel gratings having equal grating constants. Their number is inversely proportional to the distance. With the gratings in parallel planes, but the grating lines at an angle to one another, the superposed strips have different directions for different distances of the observer, and the tangent of the angle of rotation of these strips is proportional to the distance. Using gratings having slightly different grating constants a rotation of up to nearly 180° can be attained for large distances. Some of the diffraction phenomena which occur are described, a more complete representation of which is in preparation. H. G. S.

MATHEMATICAL METHODS & THEORY OF MEASUREMENTS.

1970. Solution of simultaneous linear equations in structural analysis. I. F. MORRISON. *Engng J. Can.*, **24**, *pp.* 386–387, *Aug.*, 1941.

1971. Partial derivatives of derivatives. W. S. KIMBALL. *Phil. Mag.*, **32**, *pp.* 137–154, *Aug.*, 1941.

1972. On the solution of certain differential equations of the second order. L. ROTH. *Phil. Mag.*, **32**, *pp.* 155–164, *Aug.*, 1941.

1973. Experiments in approximating to solutions of a partial differential equation. W. G. BICKLEY. *Phil. Mag.*, **32**, *pp.* 50–66, *July*, 1941.—A problem concerning the effect of varying weather conditions on the temperature in an average dwelling house and the consequent effect upon the load on the public supply system is stated in terms of an analogous electric circuit. Approx. methods are applied, by way of trial, to a pair of simpler circuits, and these involve the solution of a partial differential equation. The paper describes the success of some of the attempts and the difficulties experienced with others. G. E. A.

1974. Selection of factors in statistical investigations. G. WALKER. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 261–262, *July*, 1941.

1975. Generating functions of certain continuous orthogonal systems. A. ERDÉLYI. *Proc. Roy. Soc. Edinb. A*, **61**, 1, *pp.* 61–70, 1941.

1976. Project for the computation of mathematical tables. *Bull. Amer. Math. Soc.*, **47**, *pp.* 363–365, *May*, 1941.—Sponsored by the Bur. Stand. Wash. the following tables have now been published: Table of the first 10 powers of integers, of exponential, circular and hyperbolic functions; of Planck's radiation and photon functions; $Si(x)$, $Ci(x)$, $Ei(x)$, and grid co-ordinates (American Polyconic Projection).

See also Abstracts 2077, 2083.

MECHANICS, CLASSICAL.

1977. The Dufrénois-Lhoste method of determining the ballistic density of air. O. KIHM AND R. SÄNGER. *Schweiz. Arch. angew. Wiss. Techn.*, **7**, *pp.* 121–129, *May*, 1941. *In German.*—For the calculation of trajectories it is assumed that air density changes with height according to a definite standard law. The actual course of the change may deviate from this and Dufrénois modifies the ballistic coefficient to obtain agreement with observation as regards horizontal range. The ballistic air density is $\overline{\rho}_0 = \rho_0(1 + m)$, where ρ_0 is the real density and m is a constant. Disturbances of the course of the air density are discussed and the limits of variation of the density from the normal are determined. It is shown that the effect of a disturbance of density from the normal is greater the nearer the region of disturbance to the point of projection. Dufrénois' method is generalized, making it applicable to any standard course of air density. A geometrical interpretation of the procedure is given and is critically considered. G. E. A.

1978. The Eötvös effect and its applications. I. Szolnoki. *Naturwissenschaften*, **29**, *pp.* 273–277, *May* 9, 1941. *In German.*—The author considers the Eötvös effect, the alteration in weight of a body moving on the earth, an increase when motion is to the west and a decrease when to the east, and determines its magnitude and the factors on which it depends. Tables of values are included for making corrections to allow for the effect in a number of cases, e.g. bodies thrown horizontally, at an angle and along a steep inclined plane, artillery projectiles and aeroplanes in flight, etc. H. G. S.

1979. Train acceleration with steam locomotives. L. B. Jones. *Trans. Amer. Soc. Mech. Engrs*, **63**, *pp.* 431–437; *Disc.*, 437–438, *July*, 1941.—A study of the relation between the cylinder tractive force of high-speed steam locomotives and the energy required to accelerate trains of differing weights at various rates. Mathematical formulae for computing time and distance required for acceleration are presented in an Appendix. Consideration is given to some of the more important factors which limit cylinder tractive power. Author

See also Abstracts 2117, 2131.

MECHANICS, QUANTUM.

1980. Yukawa's theory of the β-disintegration and the lifetime of the meson. S. Sakata. *Proc. Phys.-Math. Soc., Japan*, **23**, *pp.* 291–309, *April*, 1941.—Using the orthogonality relations between the amplitudes of the meson wave functions, the general case of the interaction of mesons with heavy and light particles is discussed by a method previously developed [Abstr. 188 (1941)]. The β-disintegration formula is derived. The calculated lifetime of the meson on the vector theory is about 100 times shorter than the experimental value. On the pseudo-scalar meson theory the difficulty does not arise as the corresponding formula for calculating the lifetime of the meson does not exist. G. C. McV.

1981. Generalization of the Dirac equations. E. N. Lorenz. *Proc. Nat. Acad. Sci., Wash.*, **27**, *pp.* 317–322, *June*, 1941.—The matrix theory is worked out for the equations:

$$\sum_{m=1}^{4} (A_m + R_{tm}) \frac{\partial \Psi}{\partial x_m} - \lambda(I + R_{t0})\Psi = 0$$

Here A_m ($m = 1, \ldots 4$) are four Dirac matrices, I is identity matrix, A_0 is iI, R is a matrix such that $R A_m R = 0$ for $m = 0, 1 \ldots 4$, λ is $2\pi i/h$, and t_0, t_m ($m = 1, \ldots 4$) are arbitrary. These equations would be the analogues of Dirac's equations in a universe where there was a preferred isotropic direction. G. C. McV.

1982. Newton's force axiom in electron-wave mechanics. M. Steck. *Rev. Univ. nac. Tucumán A*, **1**, 1 *and* 2, *pp.* 67–71, 1940. *In German.*—The author shows that de Broglie's expression for electron-wavelength [Abstr. 2262, 3117 (1935)] brings wave-mechanical theory into accord with Newtonian mechanics. Ed.

1983. A generalization of Fermi-Dirac's statistical mechanics. F. Cernuschi. *Rev. Univ. nac. Tucumán A*, **1**, 1 *and* 2, *pp.* 255–265, 1940. *In Spanish.*—The author derives an equation of state for a gas in Fermi-Dirac mechanics, corresponding to van der Waals's equation in classical theory. This is applied to a gas of neutrons, with reference to the interior of a star. Ed.

1984. Note on the correspondence between the classical and quantum theories of neutral mesons. H. J. Bhabha. *Proc. Indian Acad. Sci. A*, **13**, *pp.* 249–254, *April*, 1941.—There is strict correspondence between the classical and quantum theories of neutral mesons in the sense that the classical formula is the mathematical limit of the quantum formula when $h \to 0$, but there is no correspondence in the looser sense of the term, i.e. when the quantum formula goes over to the corresponding classical formula, the energy of the quantum concerned being small compared with some other constant of the dimensions of energy involved in the formula. This is due to the fact that the classical theory of mesons only contains the fundamental const. χ, the rest mass of the meson, μ, being introduced when the theory is quantized. Owing to this lack of correspondence it is not always possible to calculate accurately the cross-section of a process by the classical theory. However, the fact that this theory can be used satisfactorily to a considerable extent is due to the circumstance that the mass of the neutron, M, is much greater than that of the meson, μ. The classical theory could not give an accurate interpretation of processes involving interaction of mesons with electrons or neutrinos, since the mass of the electron, which, in this case, replaces M, is much smaller than μ. A. J. M.

See also Abstract 2106.

SOLUTION.

See Abstracts 2076, 2130.

SURFACE PROPERTIES.

1985. The catalysis of the parahydrogen conversion by tungsten. D. D. Eley and E. K. Rideal. *Proc. Roy. Soc. A*, **178**, *pp.* 429–464, *Aug.* 15, 1941.—The parahydrogen conversion has been measured on a W surface, as a function of the surface concentration of adsorbed O, acting as a poison. This surface concentration was measured by a contact-potential method. The O would appear not only to cut down the fraction of surface available for reaction, but also to influence the reactivity of the neighbouring chemisorbed H. An important factor in this influence may be dipole-dipole interaction between the adsorbed atoms. A part at least of the O adsorbed on W can be removed at room temperature by reaction with H. Films of CO, N and ethylene, also poison the catalytic activity of W, and there is some evidence that the small conversion that does occur in their presence proceeds through the formation of a hydride surface on top of the film, rather than on gaps in it. Experiments with a number of different wires has led to evaluation of the constant A^0 in $k = A^0e^{-E/RT}$. While A^0 in 2 cases differs considerably from the average value, in all other 6 cases it approximates closely to an average. In the derived equation for the absolute rate the temperature-independent factor is $2{\cdot}6 \times 10^{20}$ mol./sec./cm.^{2} of catalyst surface, at 1 mm. pressure of H. This factor is estimated as $B^0_m = 10^{22}$ for the zero-order reaction, which is more susceptible to simple theoretical treatment. This is considered in terms of the activated-complex theory and is shown to be more in accordance with a conversion mechanism based on an interchange between loosely adsorbed H molecules and chemisorbed H rather than with the original idea of the recombination of chemisorbed H atoms. The $H_2 + D_2$ reaction has the same rate as the parahydrogen conversion, and so tunnelling is an unimportant factor in this hydrogen reaction, even at − 150°C.

AUTHORS.

1986. Conversion time formulae for heterogeneous reactions at phase boundaries of solids. II. Powders of spherical particles. K. L. MAMPEL. *Z. phys. Chem. A*, **187**, *pp.* 235–249, *Nov.*, 1940. *In German.*—The method previously developed [Abstr. 740 (1941)] is applied to the case of a powder consisting of spherical particles of equal diameters. The exact solution leads to 3 formulae for 3 time intervals with a continuous transition from one equation to the other. Approx. solutions are also given. The speed of conversion depends on the size of the particles. The max. speed occurs with certain medium radii. R. N.

1987. The forces between neutral molecules and metallic surfaces. H. MARGENAU AND W. G. POLLARD. *Phys. Rev.*, **60**, *pp.* 128–134, *July* 15, 1941.—A general formula is developed for the interaction between a neutral molecule and a metal, and its relation to the image force law is exhibited. The latter is shown to be valid only for molecules containing slowly moving charges, such as rigid permanent dipoles. A fairly accurate evaluation of the general formula involving empirical polarizabilities, f values and resonance frequencies, is made. The numerical values for a number of gases and metals are collected in tables.

AUTHORS.

1988. A new relation between surface tension and compressibility coefficient of fluids. C. SĂLCEANU. *Z. phys. Chem. A*, **187**, *pp.* 170–174, *Sept.*, 1940. *In German.*—Under the assumption that the surface tension is proportional to the number of molecules per unit length an equation is derived connecting surface tension, density, mol. wt. and coefficient of compressibility. The surface tension was found to be proportional to the $\sqrt[3]{(Nd/M)}/\sqrt{(\text{coeff. of compr.})}$, where $N =$ Avogadro's number, $d =$ density, $M =$ mol. wt. The equation was verified for a great number of organic fluids. R. N.

1989. Surface tension of capillary active organic halides. E. A. HAUSER AND G. E. NILES. *J. Phys. Chem.*, **45**, *pp.* 954–959, *June*, 1941.—Cetylpyridinium bromide and cetyltrimethylammonium iodide are among the best known of the cationic soaps which have found ever increasing application in the textile-finishing industry, and these compounds together with analogous ones have had the surface tensions of their solutions determined under comparable conditions by the pendant-drop method [Abstr. 126 (1939)]. The results are depicted in graphical form and show: (1) that the surface activity of the pyridinium salts is somewhat greater than that of the corresponding trimethylammonium salt; (2) that the surface tension is lowered in the periodic order of the halide anions, $Cl < Br < I$; (3) that the magnitude of surface-tension lowering is of the same order for each pair of halide salts, i.e. cetylpyridinium and cetyltrimethylammonium chlorides, indicating that surface-tension lowering is not dependent only on the cation, but that the anion determines its final degree. In the present case the lyophobic hydrocarbon-chain cation is capable of lowering the surface tension to a definite extent for every concentration. The results reported offer further proof for the importance of the lyotropic series of anions in colloidal systems. H. H. HO.

1990. General thermodynamic theory of the spreading of liquids to form duplex films and of liquids or solids to form monolayers. W. D. HARKINS. *J. Chem. Phys.*, **9**, *pp.* 552–568, *July*, 1941.—A comprehensive thermodynamic theory is developed for the spreading of any liquid or solid b over the surface of any liquid a. Spreading is considered to occur by 2 types of processes: duplex film or D spreading, and non-duplex or M spreading. A duplex film is always unstable, and transforms into a non-duplex film and a lens. Every non-duplex film of known structure is a mono-layer (M). Either type of film may spread if its formation involves a decrease of free energy. A liquid *b* will spread over the surface of a liquid *a* as a duplex film if the work of adhesion between the two liquids is greater than the work of cohesion in *b*. Hydrocarbons of not too high mol. wt. are found to spread on water as either duplex films or mono-layers. In general, for liquids which spread as duplex films, it takes less work to pull a liquid away from its equilibrium mono-layer than to pull it away from itself. An oil which is non-spreading in the sense of duplex film formation may be caused to spread as a duplex film by the addition of an oil of sufficiently high initial spreading coefficient. This also increases the equilibrium film pressure of the mono-layer. With such mixtures the values of the thermodynamic spreading coefficients, or the free energy levels, are highly dependent upon the nature and the concentration of the oil added. AUTHOR.

1991. Spreading of oils on water. I. Ionized molecules having only 1 polar group. W. A. ZISMAN. *J. Chem. Phys.*, **9**, *pp.* 534–551, *July*, 1941.—The spreading phenomena on water of drops of mineral oils containing a wide variety of organic acids and amines having but 1 polar group have been studied under conditions where dissociation at the oil/water interface could most readily occur. Particular emphasis is placed on the homologous series as an aid in separating the variables involved. Various phenomena of edge diffusion are described and a qualitative theory is presented. Edge diffusion is shown not to be a serious source of error in measuring the cross-sectional areas of the adsorbed molecules if there are over 13 C atoms per straight chain. The different types of film spreading and break-up effects are described, and the various physical and chemical factors involved are discussed. The changes in the spreading effects due to varying the *p*H and to the presence in the water of Ca^{++}, Cu^{++}, Pb^{++}, Fe^{+++}, Al^{+++}, La^{+++}, and Th^{++++} on the interfacial film are described. It is shown that only the long-chain monobasic saturated acids form rigid films when affected by metallic ions, while other acids are either condensed or unaffected. Short-chain metallic salts of these fatty acids are often oil-soluble and have brief lifetimes of adsorption. An experimental proof is given that dissociated long-chain acids and amines have infinite lifetimes of adsorption. Evidence is given for concluding that the lifetime is short for molecules having less than 14 C atoms. The effect of Ca^{++} on the spreading of oleic-stearic acid mixtures is given in some detail and also a theory of the results. Reasons are given for concluding that the adsorbed acid molecules form 2-dimensional film complexes with hydrocarbon molecules derived from the oil. AUTHOR.

1992. Liquid films in the viscous-flow region. S. J. FRIEDMAN AND C. O. MILLER. *Industr. Engng Chem.*, **33**, *pp.* 885–891, *July*, 1941.—In the case of flow of liquid films, bounded by solid and essentially static air interfaces, a third type of flow called pseudo-streamline has been found to exist between *Re* 25 and *Re* 1500. This type of flow is characterized by the appearance of waves in the liquid film and by a much higher interfacial velocity than that predicted by streamline flow equations. However, the Reynolds number and friction factor correlation for true streamline flow is applicable in this region. AUTHORS.

***1993. Determination of capillary constants with the Mohr balance.** J. TAGGER. *Phys. Z.*, **42**, *pp.* 53–55, *Feb.* 15, 1941. *In German.*—Instead of the sinker a rectangular metal or glass plate of a weight to produce equipoise is suspended from the Mohr balance. A wide cylindrical vessel, vertically movable, is placed beneath the metal plate and contains the liquid to be investigated. The reflected image of the lower edge of the plate enables its horizontality and distance from the surface of the liquid to be observed. On slowly raising the vessel until the edge of the plate just touches the liquid the surface forces come into play and draw the plate down. The height of the vessel is read off on a scale. On further raising the vessel the plate is more deeply immersed. At the same time it is lifted until, finally, balance is re-established. When this occurs, the upward thrust of the liquid equalizes the downward pull of the capillary forces. The difference between the present and former height readings is the depth of immersion of the plate. The state of balance is given by $2\alpha(b+d)=b\times d\times h\times s$, in which α denotes the capillary constant, *b* the width, *d* the thickness of the plate and *h* its depth of immersion, and *s* the density of the liquid. Owing to size restrictions of the liquid container the immersion of the plate raises the surface of the liquid. This increases the depth of immersion slightly, by an amount $h \times \frac{q}{Q-q}$ where *q* and *Q* are the cross-sections of the plate and vessel, respectively, so that $\alpha = h \times s \times \frac{Q\times q}{2(b+d)(Q-q)}$. Damping is effected by a wire suspended from the balance beam and dipping in a glass jar filled with water. To enable readings to be taken to 0·01 mm. the liquid container is attached to an arm of a simple cathetometer, and a microscope is used to observe the index of the balance beam. The apparatus is schematically illustrated, and results of measurements with it are included. H. G. S.

1994. Effect of some organic dye ions on the electrokinetic potential at the glass/water interface.

D. O. Jordan. *Trans. Faraday Soc.*, **37**, *pp.* 441–450, *Sept.*, 1941.—The electric moment of the double layer at the glass/water interface has been determined in the presence of 5 dyes by the streaming-potential method. Coagulation of the dye at the interface has been observed in the case of those dyes known to exist as colloidal micelles in aqueous solution. Some measurements have been made in the presence of NaCl. Author.

1995. Evidence for a rigid multi-layer at a solid/liquid interface. W. G. Eversole and P. H. Lahr. *J. Chem. Phys.*, **9**, *pp.* 530–534, *July*, 1941. —The assumption of an immobile hydrous multilayer at a wall of fixed potential was used in deriving equations relating zeta potentials, concentrations of univalent salt solution, wall potential, and thickness of the immobile layer. Calculations were made using data taken from published papers of various experimenters. Values of 8 Å to 63 Å were obtained for the thickness of the immobile layer. The values of wall potential and film thickness were considered sufficiently consistent for each set of data to justify the original assumption. Authors

See also Abstract 1961.

TIME.

1996. Perpetual and mental calendars. C. E. White. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 233–240, *July–Aug.*, 1941.—After a review of previous rule-and-formula perpetual calendars, the author points out their underlying similarity and derives a mental calendar for finding the day of the week corresponding to a given date. Three methods are given for solving the inverse problem: knowing the day of the week, to find the exact date if the approx. date is given. A. Hu.

1997. Perpetual ecclesiastical calendars. C. E. White. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 241–248, *July–Aug.*, 1941.—A mental rule is derived for finding the date of Easter. The date of crucifixion given as March 25, 31 A.D., in the Death Warrant of Christ, hitherto regarded as of doubtful authenticity, does in fact fall on a Friday. A. Hu.

***1998. Short-interval chronoscope.** H. P. Kuehni. *Gen. Elect. Rev.*, **44**, *pp.* 337–339, *June*, 1941.—A capacitor is charged from a transformer through a rectifier and resistance to a voltage which is measured by a voltmeter. Two thyratron tubes are connected across the capacitor and held non-conducting by negative bias on the grids, the recording instrument coil being connected between the ends of resistances in the anode leads of the thyratrons. The thyratrons are ignited by passage of a permanent magnet, connected to the body whose speed is to be measured, past 2 coils connected to the respective grids. The capacitor is thus discharged first through one thyratron and then through both together. The arrangement is such that the peak value of the current through the instrument coil is a measure of the time interval between the firing of the two thyratrons. The instrument coil encloses a small rod of permanent magnet steel, the remanent magnetism in which is a function of the peak value of the current through the coil. The instrument movement consists of a circular soft-iron disc mounted eccentrically on the spindle, which rotates until the torque due to the magnetic attraction is balanced by that of the instrument spring. The deflection remains constant until the steel rod is demagnetized again. This is effected by means of a damped oscillatory discharge of the capacitor through the instrument coil. Calibration is effected by attaching the permanent magnet to a rotating disc and arranging the pick-up coils at suitable angular spacings. With a spacing of 6 in. between the coils full-scale deflection is obtained for a speed of 60 m.p.h., which is increased to 120 m.p.h. when the coil spacing is 12 in. A. W.

VISCOSITY AND FRICTION.

1999. Experiments on the temperature coefficient of static friction. R. Schnurmann. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 538–546, *Sept.*, 1941.—Angles of repose of metals have been measured under controlled vacuum conditions. Preliminary measurements were made at room temperature in air. As it was found that vibrations tended to reduce the angle of repose, they were eliminated. Naked metal surfaces were obtained for Al and Cd by cleaning by volatilization in a high vacuum. Interesting results were found with a steel slider when a deposit of volatilized Al had formed on steel crutches. Experiments on Cd cleaned by volatilization at various temperatures at which the whole friction chamber was baked out were carried out in the range from + 176°C. to − 100°C. The results, in spite of the inevitable fluctuations of individual values at any particular temperature, clearly show a general drift with temperature and are a first instalment towards an approach to the thermodynamical criterion for the fundamental mechanism of friction between naked metal surfaces. A conservative analysis of the results of measurements between − 100°C. and + 100°C. leads to a temperature coefficient of the angle of repose $d\bar{\alpha}/dt = -3{\cdot}5° \times 10^{-2}$, while a bolder interpolation would raise this numerical value by a factor of about 2 ($d\alpha/dt = -8° \times 10^{-2}$). Above about + 100°C. the angle of repose of naked Cd increased with rising temperature. Author.

2000. Viscosity of liquids in homologous series. R. Linke. *Z. phys. Chem. A*, **187**, *pp.* 227–234, *Nov.*, 1940. *In German.*—For various homologous series of hydrocarbons the *A* and *B* values of the equation $\log \nu = B/4{\cdot}57\, T + A$ are calculated, where ν = cinematic viscosity in cm.^{2}/sec. and T = abs. temp. The dependence of these constants on the total carbon number follows a linear law for each series. R. N.

See also Abstracts 1944, 1992, 2163, 2168.

ASTRONOMY AND ASTROPHYSICS.

ASTRONOMICAL APPARATUS AND OBSERVATORY EQUIPMENT.

✱**2001. Improved telescope spider design.** C. H. Werenskiold. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 268–270, *July–Aug.*, 1941.—By curving the spider arms supporting the prism or diagonal assembly near the eyepiece, the author eliminates without loss of light the spikes or cross-lines in the images of bright stars viewed with a reflecting telescope. A. Hu.

COSMOGONY.

2002. Origin of the solar system. R. A. Lyttleton. *Mon. Not. Roy. Astr. Soc.*, **101**, 4, *pp.* 216–226, 1941.—The possibility of alternative hypotheses for the origin of the solar system is discussed and it appears that the removal of material from a star would be most likely to occur through the effect of rotational instability. A single mass could obtain sufficient angular momentum to cause instability as a result of the components of a double star combining into a single body. The decrease of separation required to instigate this process is a consequence of the general course of evolution of double stars. When the combined mass undergoes fission the two new components separate with hyperbolic velocity, and accordingly their initial configuration and motion reproduce the same situation met with in the collision theory of the origin of the planets. The sun is regarded as the distant companion of a close double star whose components first merge into a single body, and then this mass breaks up into a pair of stars and these produce the planetary filament as they separate from one another. Such triple systems are by no means rare in space and the formation of planets by this process may therefore be of very much more frequent occurrence than formation by any mechanism of the encounter type. [See Abstr. 2354 (1940)]. Author.

2003. On the origin of the solar system. W. J. Luyten. *Astrophys. J.*, **94**, *pp.* 136–139, *July*, 1941.—Reply is made to Lyttleton [Abstr. 2354 (1940)] more specifically in connection with the amount of planetary matter available for capture. While the objection to the previous calculations of Hill and the author is admitted to be valid in principle, it is shown that, numerically, it makes the case for the theory more adverse, reducing the amount of matter available for capture from an assumed 6% before to less than 0·6% at most. The conclusion reached before, that Lyttleton's theory is dynamically untenable, is maintained. Author.

NEBULAE.

2004. Cluster of nebulae in Hydra. F. Zwicky. *Proc. Nat. Acad. Sci., Wash.*, **27**, *pp.* 264–269, *June*, 1941.—Structural features of this cluster are analysed on photographs taken with the Mt. Palomar 18 in. Schmidt camera. Annular counts in a region within 4°10′ of the centre show 374 nebulae distributed symmetrically in the way expected for an Emden isothermal gravitational gas sphere. An assumption of − 16·4 for the abs. magnitude of the fifth brightest nebula suggests a distance of $7{\cdot}3 \times 10^6$ parsecs for the cluster. This gives an expected recessional velocity of about 4 100 km./sec. A. Hu.

2005. Physical processes in gaseous nebulae. XVI. The abundance of O III. D. H. Menzel and L. H. Aller. *Astrophys. J.*, **94**, *pp.* 30–36, *July*, 1941.—From the intensities of the green nebular lines the density of O III ions proves to be roughly 1 per cm.^{3}, corresponding to an abundance about 10^4 times less than that of the H ions. The numbers, nevertheless, are sufficient to produce a marked depression of the electron temperature, through the medium of collisional excitation. The observed electron temperatures [Abstr. 1469 (1941)] are consistent with the theory developed [Abstr. 4836 (1938)], modified for the effects of collisions. Authors.

STARS.

2006. Mean abs. magnitudes of stars of spectral types O5–B5. R. E. Wilson. *Contr. Mt. Wilson Obs. No.* 646. *Astrophys. J.*, **94**, *pp.* 12–20, *July*, 1941.—This study of the mean absolute magnitudes of the O5–B5 stars considers both the spectral classification and the character of the lines. It is based upon the radial velocities of 987 stars and the proper motions of 1 496 stars.

The conclusion is that the presence of diffuse or emission lines in the spectra is not, in general, indicative of abnormal luminosity. When the c stars, which are supergiants, are excluded, the others fall on a smooth sequence in which the mean abs. magnitude decreases from − 3·7 for class O8 to − 0·8 for class B5. The Wolf-Rayet stars have essentially the same mean luminosity as the absorption O stars. The c stars with emission lines lie on the supergiant sequence defined by the normal c stars.

2007. Magnitude scale of the bright polar standards. F. H. Seares. *Contr. Mt. Wilson Obs. No.* 647. *Astrophys. J.*, **94,** *pp.* 21–26, *July*, 1941. Recent photo-electric observations by Hassenstein provide an additional test of the photographic scale of the bright polar standards. Comparison with the magnitudes of 40 stars in the new Mt. Wilson Polar Catalogue reveals localized zero-point differences of − 0.04 and + 0.03 mag., which apparently originate in Hassenstein's measurements. After correction, the agreement with the Polar Catalogue is close (average difference ± 0·019 mag. and no scale divergence). The agreement with the magnitudes of the first 9 stars of the Polar Sequence is equally close. A direct comparison of Hassenstein with the photo-electric results of Stebbins and Whitford, on the other hand, shows for stars 1s and 1–5 the same discordance of 0·1 mag. that appears when the polar standards are compared with Stebbins and Whitford. Although no completely satisfactory explanation has been found, it seems likely that at least part of the discrepancy originates in spectral peculiarities. Author.

2008. Determination of the magnitude difference between the components of spectroscopic binaries. R. M. Petrie. *Publ. Dom. Astrophys. Obs., Vict., B.C.*, 7, 12, *pp*. 205–238, 1939.—The problem of determining Δm for spectroscopic binaries exhibiting 2 spectra is investigated from the standpoint of the measurement of spectral line profiles. It is shown that, under certain assumptions, the problem can be solved so that both Δm and a spectral class difference can be measured. The methods are applied to line profiles obtained from high-dispersion spectra, and results are secured for 17 spectroscopic binaries and 6 eclipsing systems. The values of Δm range from 0·03 to 1·50 magnitudes, the spectral classes B, A, F and G being represented. Applications of Δm to determine the masses and diameters of the stars, and the orbital dimensions, are made, and the abs. magnitudes, masses, radii and densities, are given for the 17 spectroscopic binary systems. It is shown, finally, how this work will make a contribution to the study of the relation between mass and luminosity. Author.

2009. Ellipsoidal distribution of stellar velocities. G. L. Camm. *Mon. Not. Roy. Astr. Soc.*, **101,** 4, *pp*. 195–215, 1941. *Observatory*, **64,** *pp*. 93-95; *Disc.*, 95-96, *Aug*., 1941.—The dynamical features of a stellar system possessing a generalized (non-exponential) ellipsoidal distribution of velocities are investigated. For such systems in a steady state, where the mean motion is not zero at all points, it is shown that the gravitational potential must have rotational symmetry about an axis, about which also the velocity distribution is symmetrical. The gravitational potential has to satisfy a partial differential equation whose general solution is derived. It is established that no such system of stars of equal mass can be entirely self-gravitating if it is to remain in a steady state. A. Hu.

2010. Spectrographic orbits of H.D. 207650. R. M. Petrie. *Publ. Dom. Astrophys. Obs., Vict., B.C.*, 7, 14, *pp*. 245–249, 1940.—The orbital elements for this system rest upon 36 high-dispersion spectrograms of which 29 showed the spectra of both components. The orbital elements are: $P=5{\cdot}30465$ days, $T=$J.D. 2 429 117·474, $\omega_1=302^{\circ}{\cdot}68$, $\omega_2=122^{\circ}{\cdot}68$, $e=0{\cdot}528$, $K_1=37{\cdot}01$ km./sec., $K_2=40{\cdot}35$ km./sec., and $V_0=-23{\cdot}89$ km./sec. The stars are found to be nearly alike in mass and luminosity, the inclination of the orbital plane is low, and the absolute dimensions of the stars and orbits are given. Author.

2011. Spectrographic orbit of H.D. 207826 (Boss 5620). A. McKellar and C. G. Patten. *Publ. Dom. Astrophys. Obs., Vict., B.C.*, 7, 13, *pp*. 239–244, 1940.—From the radial-velocity measurements upon 51 spectrograms of the F2 type star, H.D. 207 826 (Boss 5 620), covering the period 1919 to 1940, the spectrographic orbit of the star has been determined. The final elliptic orbital elements derived are as follows: $P=2{\cdot}72574$ days, $e=0{\cdot}025$, $V_0=-15{\cdot}25$ km./sec., $K=30{\cdot}69$ km./sec., $\omega=146^{\circ}{\cdot}9$, and $T=$J.D. 2 428 396·623. A circular orbit for the star, the elements of which are given, was also computed but was found not to represent the observations quite as well as the elliptic elements. Authors.

2012. Large-scale motion in stars. G. Randers. *Astrophys. J.*, **94,** *pp*. 109–123, *July*, 1941.—The most general type of stationary internal motion in a star of rotational symmetry is studied from a dynamical point of view, and some general theorems are obtained. The period of a stationary meridional circulation is related to the effective viscosity in the star. Restrictions on the possible distributions of angular velocity follow from the boundary conditions imposed by the cinematics, as well as by the dynamics, of the system. Author.

2013. Characteristic velocity curves of RV Tauri variables. D. B. McLaughlin. *Astrophys. J.*, **94,** *pp*. 94–98, *July*, 1941.—The light-variations of

V Vulpeculae and R Sagittae during the interval covered by the Mt. Wilson spectrographic observations are examined. A number of cycles showed various types of peculiarities, but for each star a long continuous series of normal cycles is available. When mean-velocity curves are determined from observations made during the normal behaviour of the stars, there are very few discordant velocities. The correlation of curves is similar to that found for AC Herculis and R Scuti. As far as is known, RV Tauri stars have velocity max. shortly after the principal min. of light and velocity min. about ¼ period earlier. AUTHOR.

2014. Relative *f*-values for lines of Ti II. R. B. KING. *Contr. Mt. Wilson Obs. No.* 648. *Astrophys. J.*, **94,** *pp.* 27–29, *July*, 1941.—The relative *f*-values for 63 lines in 17 multiplets of Ti II in the wavelength range λλ 3143–3761 have been measured. The method was essentially that described previously [Abstr. 535 (1936), 537 (1938)] with the exception that a h.p. mercury arc was used as the source of the continuous spectrum, thus enabling furnace absorption lines to be observed at temperatures up to 3 000°C. AUTHOR.

2015. Spectrophotometry of 67 bright stars with a photo-electric cell. J. S. HALL. *Astrophys. J.*, **94,** *pp.* 71–93, *July*, 1941.—This paper gives 728 heterochromatic magnitudes of 56 stars observed at the Sproul Observatory and 640 magnitudes of 64 stars observed at the Amherst College Observatory. The spectral regions at which these magnitudes were measured were sharply defined, and the effective wavelengths were accurately determined. The Sproul magnitudes include 13 adjacent spectral regions extending from 4 560 Å in the blue to 10 320 Å in the infra-red. The Amherst magnitudes include 10 spectral regions extending from 4 500 Å to 8 810 Å. The method of forming the spectra and of segregating and reflecting definite spectral regions to the cathode of the photocell is described. Extension coefficients were determined at 6 different spectral regions at Sproul and in all 10 regions at Amherst. The Amherst magnitudes are compared with those determined by Kienle, Strassl and Wempe, in regions extending from the blue to Hα and with magnitudes determined by Hoff for the regions farther to the red. AUTHOR.

2016. Contribution to the study of β Canis Majoris. O. STRUVE AND P. SWINGS. *Astrophys. J.*, **94,** *pp.* 99–108, *July*, 1941.—Coudé spectrograms obtained at the McDonald Observatory on January 22 and 24, 1941, show a velocity range of about 9 km./sec., in a period of 6 hrs. The lines are diffuse and shallow near min. velocity and sharper and deeper near max. velocity. The Ca II line *K* shares in the oscillations. It is probably a blend of a stellar and an interstellar line. The lines suggest turbulence of an appreciable amount. A line at λ 4 469·71 is probably a blend of O II and forbidden He I. A comparison with β Cephei shows that β Canis Majoris is more luminous. It is, however, not a supergiant. The similarity in the periods suggests similarity of internal structure. AUTHORS.

2017. On the cause of cepheid pulsation. A. S. EDDINGTON. *Mon. Not. Roy. Astr. Soc.*, **101,** 4, *pp.* 182–194, 1941.—A study of the dissipation of the energy of pulsation leads to the conclusion that the quarter-period retardation of the outflow of heat is necessarily associated with an abnormally low adiabatic constant in the non-adiabatic part of the star. This points unmistakably to the critical layer, where hydrogen is in the mid-stage of ionization, as responsible for the phase retardation. It is verified that phase change can occur in this region without the rapid decay of amplitude which might have been expected from analogy with conduction problems. For stars in general no fixed amount of phase change is indicated; but in Cepheids it will correspond to an optimum extension of the critical layer which makes the dissipation a min., the sharply reduced dissipation being the cause of the pulsatory instability. A certain amount of confirmatory evidence is found. The theory requires an amount of hydrogen in the critical layer which at first sight seems impossibly large; but it is believed that the discrepancy is removed by the study of the effects of convection. [Abstr. 2018 (1941)]. AUTHOR.

2018. Ionization equilibrium in a convective region. A. S. EDDINGTON. *Mon. Not. Roy. Astr. Soc.*, **101,** 4, *pp.* 177–181, 1941.—It is shown that the equilibrium calculation of ionization and excitation breaks down altogether in the convective layer in the sun. The descending currents convect neutral hydrogen to a depth where the equilibrium formula would give almost complete ionization, and the ascending currents convect ionized hydrogen nearly to the photosphere, This appears to be much the most important consequence of convection since it occurs at current-speeds too slow to affect the dynamical and thermodynamical equations. The effect on the opacity is investigated. One result, which bears on a great many problems concerning the outer layers of a star, is that in the photosphere and reversing layer the proportion of h.f. radiation will be greatly in excess of that given by Planck's law. AUTHOR.

2019. On the accretion theory of stellar evolution. F. HOYLE AND R. A. LYTTLETON. *Mon. Not. Roy. Astr. Soc.*, **101,** 4, *pp.* 227–236, 1941.—The discussion of accretion given in a recent paper by Atkinson [Abstr. 2062, 2369 (1940)] is considered in some detail. It is shown that most of the arguments had been dealt with before the publication of Atkinson's article, while several errors of method have led to a number of other invalid criticisms being put forward. It is shown that when these errors are set right the difficulties met with by their author are removed. AUTHORS.

2020. Cosmic abundance of the light elements. A. UNSÖLD. *Phys. Z.*, **41,** *pp.* 549–552, *Dec.* 15, 1940. *In German.*—The connection between the production of energy in the interior of the stars by nuclear reactions on the one hand and by cosmic abundance distribution of the elements on the other is represented in conjunction with the work of Bethe [Abstr. 1550 (1939)] and von Weizsäcker [Abstr. 4845 (1938)]. The bifurcation of the spectral sequence in the Wolf-Rayet stars and the cool stars can possibly be brought into agreement with the Bethe and von Weizsäcker theory. The cosmic abundance of the light elements can at present be best determined for the B-stars and the O-stars. The results obtained by applying the recent technique to the BO-star τ Scorpii are given in a curve. Specially important are: the great abundance of H; the very considerable abundance of He; the abundance ratio of C : N in agreement with Bethe's calculations; Ne normal in the cosmos (in contrast to the earth's atmosphere. Further astrophysical possibilities are indicated. H. G. S.

2021. The galactic clusters Messier 46, Messier 50, and NGC 2324. J. CUFFEY. *Astrophys. J.*, **94,** *pp.* 55–70, *July*, 1941.—A number of the clusters in the Milky Way field near Monoceros and Canis Major are being observed. The results for 3 of the clusters confirm the smallness of the selective and probably also of the general absorption in this direction to a distance of approx. 3300 parsecs. The colour excesses ($\lambda\lambda$ 4300–6200, and distances, corrected for the small general absorption by means of the $1/\lambda$ law of scattering, are: Messier 46, 0·00 mag. and 1 450 parsecs.; Messier 50, 0·30 mag. and 1 210 parsecs.; and NGC 2 324, 0·30 mag. and 3 320 parsecs. Space densities, frequencies of colour indices and other data, are given in the text. The colour/magnitude relations show, in Messier 50, that the main sequence is well defined and normal in slope and that the giant branch is abrupt and extends from abs. magnitude + 1 to − 2. In Messier 46 the slope of the main sequence is less steep than in other clusters. The presence of very blue A0 stars and also of the planetary nebula, NGC 2 438, which is located within the apparent boundaries of the cluster, combine to make Messier 46 an unusual object. The radial velocity of Messier 46 (+ 41·4 km./sec.) differs widely from that of the planetary (+ 77 km./sec.) and shows definitely that the planetary is not a member of the cluster. NGC 2 324 contains negative colour indices in spite of its low latitude and great distance; the colours show a normal main sequence and an indication of a giant branch. The absence of appreciable absorption to large distances, particularly in the case of NGC 2 324, which is located only 35° from the anti-centre direction, coupled with the absence of extragalactic nebulae from these fields, suggests that considerable absorption must occur at distances greater than 3 300 parsecs. Either an increased density of absorbing material at the boundaries of the galaxy or a spiral arm containing obscuring clouds and extending to a distance much greater than the average radius of the system is suggested as a possible explanation. AUTHOR.

2022. Variations in the periods of certain eclipsing binaries. H. HORROCKS. *Mon. Not. Roy. Astr. Soc.*, **101,** 4, *pp.* 237–248, 1941.—Data for times of min. light are collected from various sources for a selection of eclipsing binaries. They have been examined with a view to testing the constancy or otherwise of their periods. Oscillatory variations are suggested for the periods of SY Cygni and W Delphini. For other binaries, for which adequate material has been collected, quadratic light elements are derived, together with the probable errors of the coefficients on the basis of a system of probable errors assigned to the data, which seems to be satisfactory. A fairly well-determined large coefficient of E^2 is found for RS Canum Venaticorum, SW Cygni and RT Lacertae. Of the remaining stars for which quadratic light elements have been derived only TT Lyrae and RS Vulpeculae lead to determinations of rates of change of period with probable errors which are not excessive. For TW Andromedae a value for P is derived by a different method, with a moderate probable error. The results obtained are briefly discussed from the point of view of a search for evidence whether or not the periods of eclipsing binaries show a systematic progressive variation which is not too small to escape detection. Some of the stars are also discussed in relation to apsidal rotation. AUTHOR.

2023. Radial pulsations of stars. P. LEDOUX AND C. L. PEKERIS. *Astrophys. J.*, **94,** *pp.* 124–135, *July*, 1941.—It is shown that the period τ of the fundamental mode of radial pulsation of a star is given to a good approximation by the expression

$$\tau = 2\pi\sqrt{\frac{I}{-(3\Gamma_1 - 4)\Omega}}$$

where I denotes the moment of inertia of the star about its centre, Ω its gravitational potential and $\bar{\Gamma}_1$ the mean value of Γ_1 with respect to pressure. A general method of obtaining higher approximations for the period of the fundamental mode as well as for the periods of the higher modes is given and is applied to the standard model. The results obtained for the standard model indicate that, in certain cases, the approx. method yields more accurate values for the periods than have been obtained by the trial-and-error method of integrating the pulsation equation. AUTHORS.

2024. Asymmetry in the light-curves of eclipsing variables. P. H. TAYLOR. *Astrophys. J.*, **94**, *pp.* 46–54, *July*, 1941.—The light-curves of 74 eclipsing systems were examined. It was found that 33 of these are asymmetrical. The group of stars formed by selecting 1 component of each of these systems closely defines the relation $P\rho^{1/2} = 0{\cdot}37$, where P is the orbital period in days and ρ is the mean density in solar units. The explanation is proposed that asymmetry, in each case, is due to the resonance of a free period of oscillation of the component with the imposed period of change in tidal force. Two relations derived by Cowling and Emden, expressing the free period as a function of the mean density, were solved for the constant. The former, which applies for masses of homogeneous incompressible fluid, yields the value 0·314. The latter gives the corresponding period of oscillation for polytropic gas spheres, the constant being 0·20. A discussion of the data for 444 components shows that the function derived from the asymmetrical systems is an approx. upper limit for all eclipsing variables, so that very few components have lower densities. The possible identification of systems showing asymmetry with contact binaries is discussed, contact having been proposed by Kuiper to explain anomalies in the light-curve and spectroscopic details of β Lyrae. AUTHOR.

2025. Visual photometry of variable stars. H. B. BRYDON. *J. Roy. Astr. Soc. Can.*, **35**, *pp.* 153–162, *April, and pp.* 249–267, *July–Aug.*, 1941.—[See Abstr. 527 (1941)]. Instrumental photometric methods suitable for amateur work are discussed. After a comparison of the various ways of modifying a star's light by measurable amounts, the application of the several methods to stellar photometers is described. The optical systems of a number of actual photometers are sketched and practical details given of their use in stellar photometry. A. Hu.

SUN.

2026. Internal temperature/density distribution of the Sun. G. BLANCH, A. N. LOWAN, R. E. MARSHAK AND H. A. BETHE. *Astrophys. J.*, **94**, *pp.* 37–45, *July*, 1941.—An accurate determination has been made of the internal temperature/density distribution of the Sun, using the point-convective model. Account is taken of the variation of the guillotine factor throughout the star in contrast to all previous calculations on this model. The H content is adjusted so that the radiative envelope fits the convective core, where all the energy production is assumed to take place. The integration is started from the surface of the Sun, and it turns out that a H content of 35% by wt. gives a good fitting of envelope to core, whereas H contents of 40% or 30% give obvious lack of fitting in opposite senses. The interface occurs at a distance outward from the centre equal to 12% of the total radius. The central temperature is $10^6 \times 25{\cdot}7$°C. and the central density 110 g./cm.^{3} While the H content (35%) agrees with the value found with the Eddington standard model, the central temperature and central density are considerably higher than the corresponding Eddington values. If the energy source varies as the 17th power of the temperature, a dependence indicated by the astrophysical data and present theories of energy production, then the convective core contributes 98% of the total luminosity. This justifies the use of the point-convective model. Possible improvements in the calculation are discussed. AUTHORS.

2027. The continuous spectrum and the colour temperature of the sun in the region of 3 000–7 000 Å. H. KIENLE. *Naturwissenschaften*, **29**, *pp.* 124–129, *Feb.* 28, 1941. *In German.*—An analysis of the work carried out and the results obtained by various investigators in this field of research [Abstr. 1465, 1770 (1940)]. H. G. S.

GEOPHYSICS.

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2028. Heat energy from radioactive sources in the earth. W. D. URRY. *J. Wash. Acad. Sci.*, **31**, *pp.* 273–284, *July* 15, 1941.—It is shown that a determination of the heat generated by radioactivity in the earth's crust can be made by measuring the rate of α-particle emission from a number of samples. An uncertainty of less than 5% is introduced by a lack of exact knowledge of the Th/U ratio. The rate of radioactive heat production is not believed to have changed significantly for the past 2×10^9 years. Undetected radio-elements cannot have contributed appreciable heat for the past $1{\cdot}5 \times 10^9$ years. A. Hu.

METEOROLOGY.

2029. Frequency-distribution through the year of abnormally high and low daily mean temperatures at Greenwich Observatory. E. L. HAWKE. *Quart. J. Roy. Met. Soc.*, **67**, *pp.* 247–256; *Disc.*, 256–261, *July*, 1941.—This paper presents the results of an analysis of thermometric records at

Greenwich Observatory over the period 1841–1936 undertaken with the object of ascertaining the number of occasions on which each day of the year gave a mean temperature above and below the smoothed average value to specified extents. Days with positive departures of at least 10°F. and 15°F. are classed as "warm" and "very warm," and those with corresponding negative departures as "cold" and "very cold," respectively. Diagrams and tables referring these several categories to the seasons and calendar months, as well as to pentads and individual dates, are given and discussed. Instances of very exceptional heat and cold, represented by daily mean temperatures at least 20°F. above and below the average, are also listed, special reference being made to the single extant case of a positive departure so great as 20°F. (May 22, 1922). Explanations are advanced for anomalies brought to light by the investigation. AUTHOR.

2030. Study of atmospheric absorption and emission in the infra-red spectrum. J. STRONG. *J. Franklin Inst.*, **232,** *pp.* 1–22, *July*, 1941.—In a new method of plotting atmospheric-emission and solar-absorption data the radiation intensity is plotted against the square root of the number of air masses in the line of sight. For band absorption the curve so obtained is a straight line, whilst for continuous absorption the ordinary Langley diagram gives a straight line. The method therefore distinguishes between the 2 types of absorption where the spectral resolution is inadequate to settle the matter by direct observation. Residual-ray observations on radiation in the $8–13\frac{1}{2}\mu$ "window" in the solar spectrum are discussed, as well as observations of the radiation beyond the 15μ CO_2 absorption and the water vapour absorptions at $6{\cdot}3\mu$ and 21μ. Sky-emission data in the "window" are given and a theoretical explanation is advanced of Brunt's formula connecting sky radiation with the surface temperature and humidity. A. Hu.

2031. Pseudo-potential and equivalent potential temperature. F. MÖLLER. *Met. Z.*, **56,** *pp.* 1–12, *Jan.*, 1939. *In German.*—A critical survey of the errors caused by using faulty constants in determining the condensation adiabatic. After defining the pseudo-potential and the equivalent potential temperature it is shown that the latter varies during the condensation process and is therefore not suitable for investigating atmospheric processes. The pseudo-potential temperature is more suitable as it is invariant, but its computation is difficult. When wet adiabatics are calculated it must be decided beforehand whether or not the liquefied water falls out and whether, for condensation, the saturation pressure over a plane or a curved surface is to be considered. R. N.

2032. Recent experiences with Cd cell measurements. M. BENDER. *Met. Z.*, **56,** *pp.* 26–32, *Jan.*, 1939. *In German.*—[See Abstr. 2394 (1934)]. Comparative day curves are given showing the intensity of ultra-violet irradiation for 2 different levels. For the comparison of Cd cells with different spectral sensitivity the use of filters consisting of cellophane layers or uviol glass of varying thickness is recommended. Constancy tests are described. R. N.

2033. Average temperature conditions of the Alps and of the free atmosphere over sub-Alpine country. E. EKHART. *Met. Z.*, **56,** *pp.* 12–26, *Jan., and pp.* 49–57, *Feb.*, 1939. *In German.*—In order to make temperature readings comparable the observations were mainly confined to peak stations. Average values of temperature for 30 years as dependent on height, and their annual and diurnal variation, were determined by observation in 24 N.Alpine and 7 S.Alpine stations. The observations are analysed and compared with those made during 7 years' daily aeroplane flights over Munich aerodrome. R. N.

2034. Intrinsic radiation of thin humid air layers. G. FALCKENBERG. *Met. Z.*, **56,** *pp.* 72–75, *Feb.*, 1939. *In German.*—The total intrinsic radiation of humid but CO_2-free air of 20°C. enclosed in a tube of 236 cm. length was measured by means of a black radiator, cooled to the temperature of liquid air, and a thermocouple. From these and previous investigations the intrinsic radiation at 100°C. is calculated. The results are compared with those of other investigators. R. N.

2035. Solar radiation curve for summer and winter during the quaternary ice age. R. SPITALER. *Met. Z.*, **56,** *pp.* 111–118, *March*, 1939. *In German.*—Following up previous investigations [Abstr. 1895 (1932)] the author has calculated the summer and winter solar radiation curves for 1361540 before 1850 till the present time for the extreme perihelia of 90° and 270°. A table for the latitudes 0°, 30°, 45°, 60° and a graph for latitude 45° show the deviations from present values. The results are discussed and the 4 ice ages in the Alps are tentatively demarcated. R. N.

2036. Eddy diffusivity and temperature of the lower layers of the atmosphere. T. G. COWLING AND A. WHITE. *Quart. J. Roy. Met. Soc.*, **67,** *pp.* 276–283; *Disc.*, 283–286, *July*, 1941.—Methods of calculating the eddy diffusivity κ are discussed. It is shown that methods which assume that κ can be regarded as independent of the height, even through a shallow layer, lead to erroneous results: in consequence the frequent use in the literature of the approx. equation of transfer of heat $\kappa\theta'' = \dot{\theta}$ is to be deplored. It is also shown that there is a large diurnal variation of κ at any level, and that neglect of this may also lead to incorrect and discordant results. Using the values obtained for κ, it is shown that certain features of the temperature variation cannot be explained by convection alone, and it is suggested that they may possibly be due to radiation.

AUTHORS.

2037. Clear-day barometric curve at Ben Nevis. T. R. TANNAHILL. *Proc. Roy. Soc. Edinb. A*, **61**, 1, *pp.* 71–76, 1941.—An examination of the Ben Nevis barometric records shows that, when the non-periodic convex variation is eliminated, the clear-day barometric curve differs but little from the normal curve obtained from all days. The results prove that the clear-day excess found by Buchan and Omond is mainly (though not entirely) due to bias in the selection of data.

AUTHOR.

***2038. Slide rule for determining 10 000 ft. pressure.** J. R. FULKS AND R. A. DIGHTMAN. *Mon. Weath. Rev., Wash.*, **69**, *pp.* 71–73, *March*, 1941.—Data concerning upper-air circulation are usually lacking when adverse weather makes aeroplane flights dependent on instruments, i.e. when this information is most needed. A chart of pressures at 10 000 ft. is constructed daily at Seattle for the U.S., W. Canada and Alaska, by estimating upper-air temperatures at a number of coast stations and computing the 10 000 ft. pressures from reported sea-level values. The paper describes the construction of a slide rule for solving the hypsometric equation for this purpose quickly and accurately. A. Hu.

2039. Practical application of Margules's condition of equilibrium. P. RAETHJEN. *Met. Z.*, **56**, *pp.* 58–62, *Feb.*, 1939. *In German.*—Margules's formula serves for determining the slope of a boundary layer in equilibrium. It should only be applied if the boundary layer is a surface of equal front parallel wind components. It is applicable independent of whether the boundary layer represents also a surface of the temperature field. The slope of the boundary surface of the wind field against the isobar is proportional to the isobar wind differences and inversely proportional to the isobar differences of temperature. A nomogram is given for quantitative investigations on the equilibrium of temperature and wind fields. It may serve for ascertaining the tendency for rotary accelerations in the cold and warm air masses.

R. N.

2040. Comparative measurements with cup anemometers. H. GOLDSCHMIDT. *Met. Z.*, **56**, *pp.* 62–71, *Feb.*, 1939. *In German.*—The cup star should have large torque, small moment of inertia and small bearing friction, and be weatherproof. The ratio between torque and m. of i. should therefore be as large as possible. A Bibliography is given. R. N.

2041. Air retention on coasts and climate indicators. V. CONRAD. *Met. Z.*, **56**, *pp.* 75–78, *Feb.*, 1939. *In German.*—From the shape of trees observed on the English and French Channel coasts the author deduces that, in addition to sea winds caused by thermal conditions, coast winds blowing at an angle to the general drift and directed towards the shores are caused by the retention of air through coastal friction. R. N.

2042. Hydrodynamic equations in pre-canonical form and variation principle of atmospheric dynamics. H. ERTEL. *Met. Z.*, **56**, *pp.* 105–108, *March*, 1939. *In German.*—The variation principle of atmospheric motion previously derived from Hamilton's principle of stationary action [Abstr. 4016 (1933)] is brought into a uniform connection with Bjerknes's circulation theory by applying Clebsch's transformation. The pre-canonical form of the hydrodynamic equations is defined as that which in the case of barotropy leads to the canonical form as given by Stuart and Lamb. R. N.

2043. Convection theory of slip-up fronts. P. RAETHJEN. *Met. Z.*, **56**, *pp.* 95–105, *March*, 1939. *In German.*—In a previous theory the disturbance of equilibrium by the formation of cumulus clouds was explained by a change in the temperature field. The present theory, which is also based on Margules's condition of equilibrium, shows the vertical movement of the cloud-air exchange to follow a condensation adiabatic. The slope of this is much greater than that of the dry adiabatic of the laminated troposphere. Inside the cloud a circular movement and a horizontal shrinkage interact. R. N.

2044. Thermodynamic foundation of Richardson's criterion of turbulence. H. ERTEL. *Met. Z.*, **56**, *pp.* 109–111, *March*, 1939. *In German,*—Viewing turbulence as a power absorber similar to a technical refrigerating machine, the author shows that Richardson's formula for the generation of turbulence [Abstr. 1973 (1921)] may be derived from mainly thermodynamic considerations.

R. N.

2045. Aurora and geomagnetism. C. W. GARTLEIN. *Proc. Amer. Phil. Soc.*, **84**, 2, *pp.* 299–308, 1941.—Correlations are pointed out between the earth's magnetic lines of force and lines of equal auroral frequency, the positions of auroral arcs, and the angles of inclination of auroral rays to the horizon. Coronae appear always at the magnetic zenith for the time of observation. Relations between the auroral frequency curve, the sunspot cycle of 11 years and the solar rotation period of 27 days, are discussed. A correlation diagram between auroral and magnetic character figures for the same 3 hr. periods gives a correlation coefficient of 0·63. Similar correlation with auroral intensity is shown by earth-current activity. A. Hu.

2046. Unusual halo display. D. B. O. Savile. *Mon. Weath. Rev., Wash.*, **69**, *pp.* 73–74, *March*, 1941.—A complex ice-halo display witnessed at Ottawa on Jan. 27, 1941, is described. The phenomena included the horizontal parhelic circle, the sun pillar, the 22° and 46° haloes and their parhelia, the circumzenithal arc and the counter-sun. An explanation of the formation of the sun-pillar is advanced. A. Hu.

2047. Optics of atmospheric haze. E. O. Hulburt. *J. Opt. Soc. Amer.*, **31**, *pp.* 467–476, *July*, 1941.—By means of a telescopic photometer measurements were made in daylight of the brightness of a large approx. blackbody at a distance $d = 3{\cdot}2$ km. and of the brightness of the sky just above. For visual ranges from 3·2 to 15 km. the measurements agreed with theoretical relations. The angular distribution of light scattered by haze was determined (1) by measuring the brightness at various angles of a searchlight beam at night, and (2) by measuring the brightness of the horizon sky at various azimuths for a moderately low sun and a cloudless sky. The distribution was much the same for haze ranging from thin to thick. It showed pronounced forward scattering. Such a scattering distribution would occur from haze particles of various sizes, most of them being of dimensions greater than the wave-lengths of white light. Author.

2048. Blue colour of the sky. B. Hrudička. *Met. Z.*, **56**, *pp.* 119–123, *March*, 1939. *In German.*—Diurnal and annual changes in the blue colour of the sky at different locations and heights in Austria are investigated and tabulated according to Ostwald-Linke's blue standard scale. A Bibliography of 26 publications is given. [See Abstr. 2642 (1936)]. R. N.

TERRESTRIAL ELECTRICITY AND MAGNETISM.

2049. Symposium on geomagnetism. *Proc. Amer. Phil. Soc.*, **84**, 2, *pp.* 187–351, 1941.—A report commemorating the work of A. D. Bache, which covers the following papers:—Terrestrial electricity in relation to geomagentism, O. H. Gish [Abstr. 2053 (1941)]. The magnetic survey of the U.S., N. H. Heck. The significance of fossil magnetism, A. G. McNish [Abstr. 2052 (1941)]. Geomagnetic observatories and instruments, H. E. McComb. Magnetic work at sea, H. F. Johnston. Geomagnetism: world-wide and cosmic aspects with especial reference to early research in America, J. A. Fleming. Aurora and geomagnetism, C. W. Gartlein [Abstr. 2045 (1941)]. Contributions of ionospheric research to geomagnetism, L. V. Berkner [Abstr. 2051 (1941)]. Correlations of short-wave radio transmission across the Atlantic with magnetic conditions, H. E. Hallborg [Abstr. 1459B (1941)]. Magnetism and its uses, P. R. Heyl.

2050. The thundercloud as a source of penetrating particles. E. C. Halliday. *Phys. Rev.*, **60**, *pp.* 101–106, *July* 15, 1941.—The paper describes cloud-chamber experiments designed to test the hypothesis that the electrostatic fields in thunderclouds can produce showers of electrons with energies as great as those found in the penetrating radiation; 65 thunderstorms were observed and 5 000 photographs of electron tracks were taken, together with 4 500 control photographs. A statistical examination of the relative number of penetrating electron tracks seen in the 2 sets of photographs indicates that there is a very strong possibility that penetrating electrons are ejected from thunderclouds and reach the earth at considerable distances from the clouds. Evidence is thus obtained that storm clouds act as a source of penetrating electrons, but it is not known whether they are the only source. The experiments indicated that the simple hypothesis, that the penetrating electrons, after their ejection from the storm clouds, travel in helical paths about the earth's magnetic field, is untenable. Author.

2051. Contributions of ionospheric research to geomagnetism. L. V. Berkner. *Proc. Amer. Phil. Soc.*, **84**, 2, *pp.* 309–322, 1941.—The technique of radio echo-sounding of the ionosphere is described and the interpretation of the results given in terms of atmospheric ion-densities. The separation of penetration frequencies and the polarization of the reflected waves by the geomagnetic field have up to the present provided proof of the "magneto-ionic theory"; now that this is confirmed on other grounds, variations in the geomagnetic field at great heights may in the future be measured by ionospheric observation. In particular the level of flow of the atmospheric current-systems may be so determined. The connection between ionospheric ion densities and geomagnetic diurnal and secular variations is discussed, and the complicated relations between chromospheric eruptions, geomagnetic disturbances and the ionospheric irruptions which cause short-wave radio fade-outs are described. A. Hu.

2052. Significance of fossil magnetism. A. G. McNish. *Proc. Amer. Phil. Soc.*, **84**, 2, *pp.* 225–237, 1941.—The varved Pleistocene clays left at the retreat of the last glaciation contain magnetic particles aligned to the direction of the earth's field at the time of deposition, and the layering they exhibit enables a self-contained time scale to be established. Present-day measurements of the direction in which the particles are aligned can thus be interpreted as observations of the direction of the earth's field in past geologic ages. Measurements of this fossil magnetism suggest that the field has remained relatively constant in direction; such changes as were then taking place being comparable in magnitude and rate to those now observed. A model in which the earth's field and its present secular variation are represented by a set of suitably disposed dipoles is interpreted in terms of a slow back-and-forth migration of extensive magnetized regions in the rocky mantle of the earth. A. Hu.

2053. Terrestrial electricity in relation to geomagnetism. O. H. Gish. *Proc. Amer. Phil. Soc.*, **84**, 2, *pp.* 187–204, 1941.—The author discusses the magnetic storm of March 24, 1940, giving observations of the earth's magnetic field, earth currents, potential gradient in the lower atmosphere, ion density in the F_2 layer, and cosmic-ray intensity. The correlation between magnetic disturbances and earth currents is emphasized and contrasted with the lack of correspondence between the atmospheric potential gradient records and the others. Solar and lunar effects are also discussed. Theoretical and observed values of the diurnal variation of earth currents are compared, and it is concluded that the diurnal variations observed in earth currents and in geomagnetism are both manifestations of electric current systems in the upper atmosphere, the main features of which are sketched. A. Hu.

See also Abstract 2045.

RADIOACTIVITY.

2054. Determination of the life of the mesotron. N. N. Das Gupta and P. C. Bhattacharya. *Proc. Nat. Inst. Sci. India*, **6**, 4, *pp.* 713–726, 1941. —The radioactive decay of the mesotron is confirmed by a series of measurements carried out at Calcutta and at Darjeeling (2·2 Km. 16°N., geomagnetic latitude). The vertical intensity of the mesotron at Calcutta has been compared with that at Darjeeling under additional lead blocks equivalent to the mass of air between the two stations. The vertical intensity at Darjeeling under 44 cm. of lead is compared with that at an inclined direction of 40° to the zenith. Under this condition the mass traversed by the vertical and inclined rays is the same. From these measurements, as well as from the ratio of the soft to the hard component at the two stations, the life of the mesotron at rest is deduced to be about $2\cdot0 \times 10^{-6}$ sec. This is comparable with the results obtained previously by different observers. Authors.

2055. Formation of zirconium and protactinium by bombardment of thorium with neutrons. O. Hahn and F. Strassmann. *Naturwissenschaften*, **29**, *pp.* 285–286, *May* 9, 1941. *In German.*—The 25-day substance obtained by the bombardment of Th with retarded neutrons and earlier regarded as an isotope of protactinium [Abstr. 3640 (1938)] is shown to be actually a protactinium and not, as surmised, a Zr isotope of about equal period which was found in the fission of U. This Zr isotope, however, is also produced when Th is irradiated with unretarded neutrons. The Zr isotope of 17 hr. half-value period with the 75 min. Nb formed from it, first detected by Grosse and Booth [*Phys. Rev.*, **57**, *p.* 664, *April* 1, 1940] from U fission, is also separated when Th is split. H. G. S.

2056. Deuteron-induced fission in U and Th. D. H. T. Gant and R. S. Krishnan. *Proc. Roy. Soc. A*, **178**, *pp.* 474–492, *Aug.* 15, 1941.—Nuclear fission of U and Th under bombardment by deuterons of about 9 eMV has been investigated both qualitatively and quantitatively by the use of the active-deposit technique. The following results have been obtained: (i) The range of the fission fragments from both U and Th is about 2·3 cm. in air. (ii) The decay curve agrees in scale and shape with that which would be expected from a complex mixture of radioactive bodies. (iii) The active deposit has been examined for emission of β-rays, positrons, γ- and X-rays, α-particles and neutrons; the radiations are found to bear a general similarity to those resulting from neutron-induced fission. (iv) Some of the radioactive bodies have been isolated by chemical methods; some correspondence with the products of neutron-induced fission is shown. (v) The ratio of the fission cross-sections for 9 eMV deuterons and (Li + D) neutrons has been measured. (vi) The excitation function has been studied. The experimental data from (v) and (vi) are compared with calculations based on Bohr and Wheeler's treatment of the mechanism of the process. Authors.

2057. Fission yield by fast neutrons. M. Ageno, E. Amaldi, D. Bocciarelli, B. N. Cacciapuoti and G. C. Trabacchi. *Phys. Rev.*, **60**, *pp.* 67–75, *July* 15, 1941.—The fission cross-section of U was measured for neutrons produced in the following reactions: Rn+Be, D+C, D+D, D+Be, D+B, D+Li. From the fact that the mean cross-section has about the same value for neutrons of the $D+D$, $D+Be$, $D+B$ reactions, it was concluded that the fission cross-section has a value σ_f which remains nearly constant between 1 and 10 eMV. For neutrons of the Rn+Be and $D+C$ reactions the fission cross-sections seem to be, respectively, about $\frac{1}{6}\sigma_f$ and $\frac{1}{8}\sigma_f$. Finally, for neutrons of the $D+Li$ reaction the mean cross-section is equal to $1{\cdot}4\sigma_f$. This fact was interpreted by Bohr as due to successive transformations which are possible for energies of the impinging neutrons larger than 10 eMV. A similar increase of the fission cross-section was observed also in case of Th, in very good agreement with the theoretical prediction by Bohr. AUTHORS.

2058. Induced radioactivity of Kr and Xe. E. P. CLANCY. *Phys. Rev.*, **60**, *pp.* 87–90, *July* 15, 1941.—Irradiation of Kr with deuterons of 11 eMV produces Kr activities with half-lives of 102 min., 4·0 hr. and about 35 hr. When Se is bombarded with 22 eMV α-particles, Kr activities of 114 min. and about 33 hr. appear. The 114 min. period coincides with that reported by other investigators as due to a Kr isotope growing out of Br^{83}, and hence is assigned to Kr^{83}. The 102 min. period observed in deuteron irradiation is considered to be the same activity. Kr^{87}, an isotope which cannot be formed from α-particle reactions with Se, is probably the source of the 4·0 hr. activity. The weak 33–35 hr. activity is due to Kr^{79} or Kr^{81}. Kr^{85} is presumed to have an activity long or fairly short. Irradiation of Xe with deuterons produces Xe activities of 68 min., 9·6 hr. and 5·4 days. Of these the last also appears in the irradiation of Te with α-particles and is due to Xe^{133}. The 9·6 hr. activity is assigned to Xe^{135}. Xe^{137} is the most probable source of the 68 min. activity. AUTHOR.

2059. Angular distribution of α-particles produced in the Li^7-proton reaction. C. L. CRITCHFIELD and E. TELLER. *Phys. Rev.*, **60**, *pp.* 10–17, *July* 1, 1941.—The angular distribution of the α-particles ejected in the reaction, $Li^7 + H^1 \rightarrow 2\,He^4$, is discussed. It is assumed that the Li^7-nucleus is odd, that the incident proton is in a P state and that a broad and a sharp nuclear resonance level participate in the reaction. The angular momentum 0 and $2\hbar$ are assigned to the broad and to the sharp levels, respectively. The constants entering into the theory could be determined only by extending the measurements on angular dependence to proton energies higher than 400 ekV. The results are in qualitative agreement with the dependence on energy of the reaction yield and of the angular distribution observed so far. AUTHORS.

2060. Radiation protection and protective measurements. R. JAEGER AND K. G. ZIMMER. *Phys. Z.*, **42**, *pp.* 25–35, *Feb.* 15, 1941. *In German.*—The authors survey the protection, against harmful radiation, of physicists, chemists and others, engaged in nuclear and radioactive work in scientific institutions, from the biological point of view. Medical and technical institutions are not considered and the radiation dealt with is confined to ionizing rays, excluding ultra-violet rays, although referred to, but including γ-rays and neutrons. After discussing the types of injury, local and general, and mutations in plants and animals, the conception and the determination of the indifference dose (tolerance dose) are considered. An included table affords a comparison between experimental and expected results regarding the ratio of the X-ray dose to the neutron dose producing the same biological effects. A discussion follows of the relative merits of effecting protective measurements with condenser ionization chambers, sensitive ionization chambers provided with leads, and tube counter instruments, and by the photographic method. The dependence on the hardness of the radiation of the sensitiveness of condenser ionization chambers made of Aerion, and of the blackening of photographic emulsion, is illustrated by curves. Tabular results are given of measurements by the condenser-chamber method of radiation dosage of physicists working with Ra, of chemists engaged in the concentration and transference of Ra, and of personnel making neutron preparations (Ra-Be). Radiation-protective aids are considered, (*a*) with large separation of the source from the object to be protected, and (*b*) with absorption of the harmful rays. Pb-equivalent protective values are given for Pb-glass, Pb-rubber, iron, brick and slag. A comprehensive Bibliography is appended. H. G. S.

See also Abstracts 1980, 2175, 2182.

RADIATION.

ABSORPTION.

2061. Absorption curve of cosmic radiation in Pb under a water-equivalent of 1 000 m. J. BARNÓTHY AND M. FORRÓ. *Phys. Z.*, **41**, *pp.* 538–540, *Dec.* 15, 1940. *In German.*—The experiments and the method used in carrying out cosmic-ray absorption measurements in the Dorog coal mines are described. Absorption measurements are made in Pb of thicknesses up to 92·5 cm. and 82 cm. at depths of a water-equivalent of

957 m. and 941 m., respectively, with a wood layer above the apparatus of 70 cm. The absorption curve shows one or several sharp min. and max. according to the test conditions. The explanation given is that at depths of a water-equivalent in excess of 500 m. only 1 component of the cosmic radiation, probably consisting of neutrinos or neutrons, penetrates and releases ionizing secondary rays of 10 or 25 cm. range, probably mesons, in the marl and brickwork above the apparatus as well as in the Pb absorber; and from the wood over the apparatus are liberated rays of a range of 40 cm. Pb, which may be protons. H. G. S.

COLORIMETRY.

2062. Photometric method for the determination of Mg. W. S. Gillam. *Industr. and Engng Chem.* (*Analytical Edition*), **13,** *pp.* 499–501, *July* 15, 1941.—A colorimetric method, based on the use of titan yellow and a photo-electric colorimeter, affords a rapid and reliable means for determining Mg in quantities ranging from 0·5 to 300 p.p.m. in fertilizers and soil extracts. Author.

***2063. Application of a photo-electric colorimeter.** R. C. Sproull and A. O. Gettler. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 462–465, *July* 15, 1941.—The principal factors which affect the application of the KI method for the determination of Bi in biological materials are evaluated. Authors.

***2064. Photo-electric colorimetric technique for the dithizone system.** F. L. Kozelka and E. F. Kluchesky. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 484–487, *July* 15, 1941.—A technique adapted for the determination of 1 component in a 2-component system is described. The technique is especially adaptable to the dithizone system because it eliminates the necessity of removing the excess dithizone and the use of standard dithizone solutions. It simplifies considerably the procedure for routine analysis. Recoveries of ± 1 μg. of Pb are obtainable. Authors.

ELECTRO-OPTICAL AND MAGNETO-OPTICAL EFFECTS.

2065. Kerr effect and molecular arrangement in highly compressed gases and liquids. E. Kuss and A. H. Stuart. *Phys. Z.*, **42,** *pp.* 95–105, *April,* 1941. *In German.*—The dependence on pressure of electric birefringence is investigated with reference to existing data on molecular polarization and molecular refraction. The pressure tube in which the Kerr condenser is incorporated and with which the measurements were conducted with N_2, CO_2, C_2H_4, CH_4 and A up to a pressure of 400 atm. is described. The double refraction is determined by the half-shadow method and an approx. formula established. The results of the measurements, which are given in tables and curves, are critically discussed. H. G. S.

EMISSION.

2066. Finite self-energies in radiation theory. I. A. Landé. *Phys. Rev.*, **60,** *pp.* 121–127, *July* 15, 1941.—According to Dirac, electric particles display a finite radius $r_0 = 2e^2/3mc^2$ as the result of the damping term $(2e^2/3mc^3)d^3x/dt^3$ in the equation of motion. If the finite radius is due to radiative damping, the same must necessarily be true for the finite self-energy that is inversely proportional to the radius. An infinitely large self-energy and an infinitely small radius (Coulomb's law e^2/r) results from Fermi's Fourier representation of classical electrodynamics. A certain change is necessary, but the change is to produce at once a finite self-energy and a finite radius r_0. Now, an electric particle vibrating in a field of frequency ν suffers a reduction R_ν of its vibrational energy due to radiative damping, the energy reduction factor being $R_\nu = 1/[1 + (\nu/\nu_0)^2]$ where $\nu_0 = 3mc^3/4\pi e^2$. It is proposed that the Fourier terms in the expression for the energy in Fermi's classical radiation theory be reduced by the same factor R_ν with Doppler effect for particles in motion. The result is that r_0 now occurs in a modified Coulomb energy $(e^2/r)[1 - \exp(-r/r_0)]$, and the finite self-energy of a single particle becomes $e^2/2r_0 = (3/4)mc^2$. Whereas the force between charged particles of finite mass remains finite for $r = 0$, the force on an ideal test charge of infinite mass becomes infinite for $r = 0$. This is analogous to the difference between the field E and the displacement D in Born's unitary-field theory. Of interest for nuclear reactions are the electrostatic forces between particles of different masses m and M. The results are related to Sommerfeld's fine-structure constant and to the theory of mesons. Author.

2067. Extensive cosmic-ray showers and the energy distribution of primary cosmic rays. N. Hilberry. *Phys. Rev.*, **60,** *pp.* 1–9, *July* 1, 1941. —An experiment is described which determines the variation in the number of extensive cosmic-ray showers per unit time with altitude from sea level up to 4 300 m. The number of showers which should have been observed with the apparatus used is calculated on the basis of the cascade theory, in which various power-law energy distributions for the primary cosmic rays are assumed. Good agreement is obtained between the observations and the calculation at high altitudes for suitable choice of parameters; at low altitudes the observed excess is what would be expected from a mesotron component in the extensive showers. It is found that the same choice of parameters which will give good agreement with the extensive shower data will also describe cosmic-ray observations at much lower energies. It is pointed out that this offers strong support for the hypothesis that there is but 1 type of primary cosmic-ray particle. The effects of choosing the proton as this primary particle are discussed.

AUTHOR.

2068. Temperature effect of cosmic rays. W. KOLHÖRSTER. *Phys. Z.*, **41**, *pp.* 532–537, *Dec.* 15, 1940. *In German.*—The results derived from the records, extending for 1½ years, of the intensity of vertical incoming cosmic rays observed with double-coincidence counting sets [Abstr. 1984 (1938)] over the sun's rotations from Sept. 14, 1938–April 30, 1940, are discussed and given in 4 tables. In the annual period both pressure and temperature distinctly show negative coefficients and effects for 10 cm. Fe- and 8 cm. and 10 cm Pb-filtered vertical rays as well as for unfiltered and coupled rays, and the effects can be interpreted as interval effects in the sense of the meson hypothesis. The diurnal period indicates positive correlations and effects with temperature which strongly depend upon the filtering. The temperature effect would appear to consist of 2 concurrent opposed effects, the negative effect, as it occurs in the annual period, and the positive absorption effect of the soft components, the latter effect preponderating in the diurnal period. For the interval effect to be fully effective the absorption effect of the soft rays would amount to about +0·14% per deg.C. from the difference of the filtered and to about +0·17% per deg.C. of the unfiltered, approx. equal. Similar considerations apply to the pressure effect, only the additional influences due to pressure variations in the diurnal period follow in the same sense as during the annual one and thus give rise to greater negative pressure effects. The additional influence amounts to about −5% per cm. Hg, in agreement with earlier considerations on the pressure effect of the soft components. A Bibliography of 27 references is included. H. G. S.

2069. Diurnal variations of cosmic radiation. W. KOLHÖRSTER. *Phys. Z.*, **42**, *pp.* 55–57, *Feb.* 15, 1941. *In German.*—Curves give the % deviations from the mean values of the diurnal variations of the cosmic-ray intensities recorded at Dahlem for rays from the vertical at 0 ± 15° and those under 45 ± 15° from the north, east, south and west. The technique and instruments used are described. The results, given in a table, are interpreted as implying that the ordinary magnetic effect is not alone concerned in the observed shifts of the times of occurrence of the diurnal extremes for the different azimuths. It must be assumed that the so-called knee of the latitude effect, so far only observed under a geo-magnetic latitude of 50°, extends over 52·38°. [See Abstr. 4166 (1936)].

H. G. S.

See also Abstracts 2054, 2061.

FLUORESCENCE & PHOSPHORESCENCE. LUMINESCENCE AND AFTERGLOW.

2070. Studies on luminescent materials. III. Photoconductivity and the molecular vibration structure of fluorescence spectra of the ZnS crystal phosphors. Y. UEHARA. *Bull. Chem. Soc. Japan*, **16**, *pp.* 99–105, *April*, 1941.—[See Abstr. 2779 (1940).] By a method similar to that of Mott the energy required to lift an electron from an excited Zn level in the crystal to the conducting band is found to be 0·08/eV for pure ZnS, supposedly activated with Zn atoms. Theoretical values are compared with those observed by Lentz [Abstr. 2755 (1925)]. A photometer trace of the blue luminescence band of pure ZnS is given, showing numerous fluctuations which the author interprets as due to the molecular vibrations. It is claimed that the observed band is represented by the formula

$$\nu = 18\,050 + 315(\nu' + \tfrac{1}{2}) - 236(\nu'' + \tfrac{1}{2}).$$

J. E.

2071. Luminescent materials' war-time uses. *Electrician*, **127**, *pp.* 17–18, *July* 11, 1941.—A summary of Bulletin C 17 issued by the Ministry of Home Security. Attention is drawn to BS/ARP 18 which defines the properties required in luminescent materials made up in the form of paint. Two types of phosphorescent materials are considered:—"A" having high brightness during and for a short time after irradiation, but a short afterglow; "B" having a lower brightness but a longer afterglow. Characteristics of materials and their applications are described, and the use of various lamps as sources of ultra-violet excitation is discussed. A. P. W.

2072. Excitation of crystal phosphors by corpuscular rays. F. MÖGLICH AND R. ROMPE. *Phys. Z.*, **41**, *pp.* 552–555, *Dec.* 15, 1940. *In German.*—The transfer of the energy from the colliding particles to the crystal phosphor takes place directly through the electron gas of the crystal. The energy absorbed by the electrons is radiated in accordance with the representations of Schön and Riehl [Abstr. 2113 (1940)]. A fast electron produces in the electron gas an electron shower with progressively diminishing energy, while an α-particle gives rise to a large number of relatively slow electrons, each of which becomes the starting point of an electron shower. The life of an excited electron is very much longer in the former than in the latter case, as it increases with

$V^{3/2}$. The electrons excited by electron collision are thus exposed to collisions of the lattice to a greater extent than are the electrons whose showers are released by heavy particles. This explains why the quantum yield, as observed, is so much better when the crystal phosphor is excited by heavy particles than by electrons. H. G. S.

INTERFERENCE, DIFFRACTION AND SCATTERING.

See Abstract 1969.

PHOTOCHEMISTRY (INCLUDING PHOTOGRAPHY).

2073. The photochemical primary process of ions in aqueous solutions. J. Weiss. *Trans. Faraday Soc.*, **37**, *pp*. 463–470, *Sept.*, 1941.

2074. Photochemical reactions in silk. H. A. Rutherford and M. Harris. *Bur. Stand. J. Res. Wash.*, **27**, *pp*. 81–88, *July*, 1941.—The stability of silk to light appears to be in part influenced by the cations in the silk. The removal of cationic substances from silk by 2 independent methods results in practically identical decreases in the stability of the fibres to light; the introduction of cations by treatment with basic compounds appreciably increases the stability. Authors.

2075. Theory of photosynthesis. J. Franck and K. F. Herzfeld. *J. Phys. Chem.*, **45**, *pp*. 978–1025, *June*, 1941.—A critical review shows that no theory hitherto published is in sufficient accord with facts to be regarded as adequate. The theory here developed is based on most recent reliable experimental evidence and assumes that the process can be divided into 3 parts: the initial process of CO_2 intake, the main photochemical process, and the liberation of O_2 from the peroxide. Each of these parts embodies catalytic reactions, with specific catalysts. In the main photosynthetic sequence there are 8 reactions arranged in 2 groups of 4, so that the reactions belonging to the two different groups alternate. In a detailed mathematical treatment equations for this main process are developed and results of the assumptions are discussed. N. M. B.

2076. Efficiency of the primary photochemical process in solution. K. Atwood and G. K. Rollefson. *J. Chem. Phys.*, **9**, *pp*. 506–512, *July*, 1941.—A study has been made of the effect of an inert solvent on the efficiency of the primary process in the photolysis of oxalyl bromide and nitrosyl chloride. The solvent used was carbon tetrachloride. The results are discussed in terms of the Franck-Rabinowitch hypothesis and it is pointed out that they are most readily accounted for by assuming a de-activating action of the solvent rather than a high efficiency of recombination. Authors.

2077. Matrix algebra and colour reproduction. C. W. Miller. *J. Opt. Soc. Amer.*, **31**, *pp*. 477–482, *July*, 1941.—The colour of an object is characterized by 3 reflection densities, measured through 3 primary colour filters. A set of subtractive primaries is characterized by a colour matrix in which the elements are the densities of unit concentrations of the primaries. The vector density which characterizes a reproduction is obtained from the vector density of the subject by operating on it with the matrix. Two successive reproductions are characterized by the matrix product of the two individual matrices. The character of the masking which is required for correct reproduction is determined by the inverse matrix. A method is described for appraising the results to be achieved by any scheme of partial masking, and these results are applied to successive reproductions such as are involved in reproducing a Kodachrome transparency. The method is applied to calculating the masking which is required in a reproduction to compensate for errors which are anticipated in a subsequent reproduction. The extent to which these matrix calculations are vitiated by the non-additivity of the constituent densities is discussed. Author.

2078. Subtractive colour mixture and colour reproduction. D. L. MacAdam. *Commun. No.* 681 *Kodak Res. Lab. Photogr. J.*, **81**, *pp*. 373–387, *Aug.*, 1941.—The colours of mixtures of certain sets of dyes can be predicted to a close approximation through the use of a simple rule. The inclusion of the phenomena of subtractive mixture in the theory leads directly to the conclusion that masking is an essential step in any realizable subtractive process of correct colour reproduction. Formulae for the calculation of the gradients of the masks are given in terms of the parameters of the rule for the prediction of the colours of mixtures of the dyes to be used in printing the subtractive reproduction. Formulae are also given for the calculation of the gradients of masks to be used for the simultaneous introduction of partially negative spectral sensitivities. An application of these formulae to the Eastman wash-off relief process shows that the negative portions of the theoretically desirable spectral sensitivities are negligible, and that each separation negative need be printed in register with only one mask. Author.

See also Abstracts 2113, 2174.

PHOTOMETRY.

2079. Subjective photometry of coloured light sources. A. Dressler. *Naturwissenschaften*, **29**, *pp.* 225–236, *April* 18, 1941. *In German.*—After a comprehensive survey of the existing state of knowledge of subjective heterochromatic photometry the author gives the conditions essential for ensuring the reliability of results, e.g. the importance of the method adopted conforming to the additive law, the use of the V_λ values recommended by the I.C.I. in 1924, the selection of observers according to their Y/B classification, a field-size of 2° and a field-brightness between 25 and 50 equivalent flux.

H. G. S.

2080. Brightness of the + crater of the pure carbon arc and the temperature of volatilization of carbon. W. Finkelnburg. *Phys. Z.*, **41,** *pp.* 559–563, *Dec.* 15, 1940. *In German.*—Measurements are made of the mean brightness at the centre of the crater with a photocell having a diameter $\frac{1}{3}$ to $\frac{1}{5}$ of the dia. of the image of the crater. The luminous surface of the crater is strongly magnified on the cell and the mean brightness is calculated from the intensity of illumination of the image and the geometrical relationships. With the + pure and homogeneous carbon arc the brightness increases almost linearly with the current, as shown by the curves embodying the results of the measurements. A rise above 18000 to over 19000 stilb (1 stilb = 1 Hefner candle/cm.^{2}) is in general interrupted by the hissing which sets in at the higher loads. It can, however, be occasionally continued to at least 25 000 stilb, as the experiments with heavily overloaded non-hissing 7 mm. homogeneous carbons show. Corresponding to this increase of brightness with load of the + crater the temperature of the crater must depend upon the current, and this temperature cannot be the sublimation temperature of carbon. The true crater temperature corresponding to the brightness of 18 500 stilb, the value usually adopted for calibration purposes since Lummer, amounts to 4 000°K., and the temperature of volatilization of carbon must be be several 100 deg. higher. This result is in agreement with the work of other investigators.

H. G. S.

***2081. Rotating differential photo-electric photometer for precision work.** J. T. MacGregor-Morris and A. G. Stainsby. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 584–594, *Sept.*, 1941.—Methods of photometry using Se cells of the rectifier type are discussed. The design of a new photometer in which 2 cells in opposition are rotated is given, together with an account of its performance. It enables a photometric study to be made of fluctuations of the order of 1 sec.; also, where photometric conditions are sufficiently stable, the ratio of the c.p. of 2 sources of the same colour can be determined to well within 1 : 500 in a few secs.

Authors.

***2082. Photo-electric vitamin A photometer.** B. Demarest. *Industr. Engng Chem.* (*Analytical Edition*), **13,** *pp.* 374–376, *June* 16, 1941.—Since vitamin A has an absorption peak at 3 280 Å an instrument for measuring photo-electrically the absorption of fish liver oils in the neighbourhood of 3 280 Å would give a means of rapid and objective vitamin A measurement. The instrument described uses a Zn vapour lamp (preferable to a Na or A lamp) as a light source and a single photocell. Details of operation and precision, with illustrative data of measurements, are given. [See Abstr. 234 (1941)].

N. M. B.

POLARIZATION.

2083. New calculus for the treatment of optical systems. I. Description and discussion. R. C. Jones. **II. Proof of 3 general equivalence theorems.** H. Hurwitz, Jr. and R. C. Jones. **III. The Sohncke theory of optical activity.** R. C. Jones. *J. Opt. Soc. Amer.*, **31,** *pp.* 488–503, *July*, 1941.—The effect of a plate of anisotropic material, such as a crystal, on a collimated beam of polarized light may always be represented mathematically as a linear transformation of the components of the electric vector of the light. The effect of a retardation plate, of an anisotropic absorber (plate of tourmaline; polaroid sheeting), or of a crystal or solution possessing optical activity, may therefore be represented as a matrix which operates on the electric vector of the incident light. Since a plane wave of light is characterized by the phases and amplitudes of the 2 transverse components of the electric vector, the matrices involved are 2-by-2 matrices, with matrix elements which are in general complex.—The general theory is used to prove 3 equivalence theorems : Any optical system which contains only retardation plates and rotators is optically equivalent to a system containing only 2 plates—one a retardation plate, and the other a rotator. A similar theorem holds for partial polarizers. The most general optical system which contains any number of all 3 types of plates is optically equivalent to a system containing at most 4 plates—2 retardation plates, 1 partial polarizer, and 1 rotator.—Reusch and Sohncke have examined the properties of a system containing a large number, n, of identical retardation plates, each of which is rotated with respect to the one preceding it through the angle ω. The product of n amd ω must be equal to μn, where μ is an integer. Under certain conditions this system is optically equivalent to a simple rotator. This system is given a treatment which is completely rigorous and which is more general than any given heretofore.

Authors.

2084. Depolarization of light scattered by liquids. K. S. Bai. *Proc. Indian Acad. Sci. A*, 13, *pp.* 439–460, *May*, 1941.—The depolarization of scattered light for slit widths ranging from 2000 μ to 10 μ of a spectrograph of high dispersion and resolving power has been investigated for 18 liquids. Graphs are drawn with half slit widths as abscissae and the observed depolarization as ordinates. In all cases the curve is nearly horizontal up to about 10 cm.$^{-1}$ below which it falls off rapidly. Contrary to the conclusions of Rousset, but in agreement with the observations of Ranganadham and Saxena, the depolarization of the unmodified line corresponding to the limiting slit width is finite for all liquids studied. It is concluded that the relative intensity of the unmodified part of rotational scattering in a liquid depends on its viscosity and, as the temperature is raised, a part of it is released and re-distributed as an exponential function of the frequency shift. H. H. Ho.

2085. Optical rotatory relationships exhibited by aromatic and aliphatic glycosides. W. W. Pigman and H. S. Isbell. *Bur. Stand. J. Res. Wash.*, **27**, *pp.* 9–25, *July*, 1941.

REFLECTION, REFRACTION AND DISPERSION.

2086. Aluminium reflectors. Y. Moriya. *Electrotechn. J.*, **4**, *pp.* 268–269, *Dec.*, 1940.

2087. Colours of ceramic tiles. P. Moon. *J. Opt. Soc. Amer.*, **31**, *pp.* 482–487, *July*, 1941.

2088. Spherical aberration in optical systems. T. Y. Baker. *Proc. Phys. Soc., Lond.*, **53**, *pp.* 531–537, *Sept.*, 1941.—The paper deals with the shapes of caustics when aberrations of higher order than the first are taken into account. It is shown that, where a system is under-corrected at the "zone," it should be substantially under-corrected at the edge in order to obtain the best performance. Author.

2089. Temperature coefficient of density and refractive index for hydrocarbons in the liquid state. M. R. Lipkin and S. S. Kurtz, Jr. *Industr. and Engng Chem.* (*Analytical Edition*), **13**, *pp.* 291–295, *May* 15, 1941.—Using the generally accepted equation $dt/4 = d20/4 + \alpha\,(t - 20) + \beta\,(t - 20)^2$, where d is the density, α the temperature coefficient $\Delta d/\Delta t$, and β covers the variation of $\Delta d/\Delta t$ with temperature t, a single curve of α/mol. wt. and one of β/mol. wt. have been found applicable to almost all types of hydrocarbons. From these curves the temperature coefficient of density of a liquid hydrocarbon at atm. pressure can be predicted from the mol. wt. within ± 0·00002 g./cm.^{3}/deg. The only definite exceptions to this relation are C_6H_6, pentaethyl- and hexapropylbenzene, which show coefficients 0·00010 g./cm.^{3}/deg. higher than predicted. The curves are also applicable to hydrocarbon mixtures. Since, for hydrocarbons, $\Delta n = 0{\cdot}60\,\Delta d$, a satisfactory method for calculating change in refractive index is also provided. N. M. B.

2090. Systematic constructional tables for thin cemented aplanatic lenses. E. D. Brown and T. Smith. *Proc. Roy. Soc. A*, **178**, *p.* 525, *Aug.* 15, 1941.—The tables give all the information needed for the construction of cemented aplanatic lenses made of only 2 refracting media, when the object is at infinity and when the image is equal in size to the object. In the former case 2 series of unsymmetrical doublets are specified and in the latter 2 series of symmetrical triplets. The refractive indices range from 1·33333 to 2·00000 and the intervals are small enough for interpolation. Authors.

tables published in Phil. Trans. (#814) 59-116 Oct 31, 1946.

2091. Charts for testing lens resolution. I. C. Gardner. *Misc. Publ. U.S. Bur. Stand.*, *M*166, [8 *pp.*], 1941.

2092. The phase-contrast method and its applications in microscopy. A. Köhler and W. Loos. *Naturwissenschaften*, **29**, *pp.* 49–61, *Jan.* 24, 1941. *In German.*—By a further development of Abbe's theory of image formation in the microscope Zernike [Abstr. 3570 (1934)] was able to show that, by changing the phase of a part of the light, image contrast in the microscope can be increased. The theoretical principles of this phase-contrast method are fully dealt with and the reasons pointed out for using small, circular phase discs. The chief differences between bright field and dark field and positive and negative phase-contrast are discussed. In many cases it is shown that the new method is basically superior to the dark field and bright field. The pictures produced more closely resemble the objects than by the methods so far used. Uncoloured, even living, preparations can be observed and photographed with a degere of clearness hitherto thought unattainable. H. G. S.

SPECTROSCOPY.

2093. Density dependence of the shift of the high alkali series lines by other gases. C. Füchtbauer and G. Häusler. *Phys. Z.*, **41**, *pp.* 555–559, *Dec.* 15, 1940. *In German.*—The shift by Ne of the higher main series lines of Ru (1*S*–14*P* to 1*S*–20*P*) is investigated. It is towards the violet and becomes constant at the end of the series for all lines at each density. The shift increases in direct proportion to the relative density. No indication is obtained of the behaviour to be expected from the Fermi calculation, that the shift should pass from violet to red with increasing relative density, despite extension of the investigation to a relative density of 16. This means that the portion of the shift dependent upon the dielectric constant must be proportional to the density of the disturbing gas. H. G. S.

2094. The spectra of Cd IV, In V and Sn VI in the iso-electric sequence Rh I to Sn VI. M. GREEN. *Phys. Rev.*, **60,** *pp.* 117–121, *July* 15, 1941.—The spectra of Cd IV, In V and Sn VI were photographed in the region 270 Å to 1 800 Å with a 3 m. normal-incidence vacuum spectrograph with a highly condensed h.v. vacuum spark as source of light. The irregular-doublet law and the law of constant second difference were applied in the classification of many of the lines of these ions. The separation of the $4d^9\,{}^2D$ multiplet of the ground state has been found for all 3 ions. Most of the odd terms arising from the $4d^8 5p$ electron configuration and some of the even terms arising from the $4d^8 5s$ electron configuration have been determined. Classifications have been made for 185 lines of Cd IV, 43 lines of In V and 39 lines of Sn VI, making possible the assignment of 51 term values for Cd IV, 32 for In V and 25 for Sn VI. AUTHOR.

2095. Spectroscopic investigation of hydrocarbon flames. W. M. VAIDYA. *Proc. Roy. Soc. A*, **178,** *pp.* 356–369, *July* 31, 1941.—Spectra of flames of the 3 principal hydrocarbons and of compounds found as intermediate products in the chemical studies of their combustion, namely methyl alcohol, formaldehyde, formic acid and acetaldehyde, have been examined. Spectra of other flames, useful for comparative purposes, such as ether, ethyl, alcohol, etc., are also described. Using a flame separator, independent observations of the outer and inner cones were made in many cases. It has been found that the outer cones give a spectrum identical with the CO flame spectrum, and the inner cones give in general C^2, CH, HO and the ethylene flame bands. It is suggested that C_2 may be produced through collisions of CH The problem of the emitter of the ethylene flame bands is also discussed. The prevalent theories of hydrocarbon combustion are then surveyed in the light of the spectroscopic observations. AUTHOR.

2096. Spectroscopic observations on hydrocarbon flames in atomic oxygen. K. H. GEIB AND W. M. VAIDYA. *Proc. Roy. Soc. A*, **178,** *pp.* 351–355, *July* 31, 1941.—Flames of hydrocarbons, burning in atomic oxygen, have been re-examined in order to find out whether the ethylene flame bands occur in such flames. The results indicate that they are strong in benzene and acetylene, but weak and diffuse in ethylene. C_2, CH and HO are also present. Methyl alcohol gives the HO and CH bands and also "cool flame" bands rather faintly, while formaldehyde shows only the HO band at λ 3064. The ethylene flame bands are absent from the flame of benzene burning in atomic hydrogen, which yields only C_2 and CH bands. The Balmer lines also appear, however, due to stray light from the main discharge. AUTHORS.

2097. Absorption of light by normal and CO-infested blood. R. G. LOYARTE, R. CARRATALA AND D. VUCETICH. *Publ. Fac. Cienc. Fis.-Mat., La Plata,* **11,** *pp.* 1–32, *April,* 1941. *In Spanish.*—This is the first part of a general investigation into the complete absorption spectra (2 000–9 000 Å) of normal and poisoned blood, *in vitro* and *in vivo*. Three spectroscopes were used, a Hilger D77, a Zeiss 3-prism and a Hilger quartz. Rejecting the criterion of mere visual displacement of the intensity curve of CO-hemoglobin relative to that of O-hemoglobin the authors used a recording microphotometer and found an intensity change varying widely from one wavelength to another. It was also found that normal blood decomposes more rapidly than CO-poisoned blood. ED.

2098. Infra-red absorption spectrum of propane. V. L. WU AND E. F. BARKER. *J. Chem. Phys.*, **9,** *pp.* 487–491, *July,* 1941.—Of the 27 internal degrees of freedom of propane, all non-degenerate, 22 may appear as fundamental absorption bands. These bands fall into 3 symmetry classes, A_1, B_1 and B_2, distinguishable by their characteristic contours. An A_1 band at 870 cm.$^{-1}$ and a B_2 band at 748 cm.$^{-1}$ have been partially resolved, the line spacing being about 1·47 cm.$^{-1}$, in agreement with predictions based upon electron diffraction measurements. The fine structure of the B_1 bands has not been observed (the predicted spacing is 0·5 cm.$^{-1}$) but the interval between max. of the P and R branches is approx. 26 cm.$^{-1}$ as expected. With 24 cm. atm. of gas no bands were observed between 15μ and 35μ, although the symmetrical C–C deformation might be expected to produce a band of appreciable intensity within these limits. This frequency has apparently been observed in Raman spectra at 375 cm.$^{-1}$. AUTHORS.

2099. Spectroscopic studies of the simpler porphyrins. III. V. M. ALBERS AND H. V. KNORR. *J. Chem. Phys.*, **9,** *pp.* 497–502, *July,* 1941.—The molecular absorption coefficients of *ms*-tetraphenylporphine and 12 complex salts have been measured over the visible region of the spectrum. Absorption coefficient/wavelength curves are shown. The variations in the spectra of the metal salts of this porphine are greater than those in the spectra of the different *ms*-tetrasubstituted porphines studied previously [Abstr. 1026 (1941)]. AUTHORS.

2100. New faint hydrocarbon band (CH)—λ4 889. W. M. VAIDYA. *Proc. Nat. Inst. Sci. India*, 7, 1, *pp.* 89–92, 1941.

2101. Absorption spectra of $CoCl_2$ solutions. II. Non-aqueous solutions. Á. VON KISS AND M. RICHTER. *Z. phys. Chem. A*, **187,** *pp.* 211–226, *Nov.*, 1940. *In German.*—Previous investigations [Abstr. 4531 (1937)] are continued and extinction curves are given for wavelengths between 200 and

700 mμ at room temperature for aqueous solutions of CoCl$_2$, solutions in water and non-electrolyte mixtures of various concentrations, in organic solvents, and for solutions of pyridine- and quinoline-complexes of CoCl$_2$ in organic solvents. Intermediate complexes are formed, the nature of which remains unsolved and which cause the spectra to be dependent on concentration. R. N.

2102. Absorption spectra of the phenylpyridines and pyridyldiphenyls. A. E. Gillam, D. H. Hey and A. Lambert. *J. Chem. Soc.*, *pp.* 364–367, *July*, 1941.

2103. Opposed axial orientations of atoms in the electric field. J. Stark. *Phys. Z.*, **42,** *pp.* 45–47, *Feb.* 15, 1941. *In German.*—From the intensity asymmetry of the red and violet displaced components of the higher members of the diffuse parhelium series by superposition of electric field and canal rays, and from the resolution of lines $2P, p-m, p$, further of $1s-mp$ and of $2s-mP$ into a doublet by the electric field, it follows that in the electric field heavy atoms, such as H, also undergo opposed axial orientations. H. G. S.

TRANSMISSION.

See Abstract 1957.

VISION.

2104. New phenomena of physiological optics. E. Gehrke. *Phys. Z.*, **41,** *pp.* 540–543, *Dec.* 15, 1940. *In German.*—New tests are given which show that depth and size impressions are linked in seeing with both eyes as well as with one eye. The effect is strengthened or weakened by other vision stimuli, such, for instance, as glare. H. G. S.

2105. Recognition of coloured light signals. J. G. Holmes. *Trans. Illum. Engng Soc., Lond.*, **6,** *pp.* 71–94; *Disc.*, 94–97, *Aug.*, 1941.—Part 1 describes the construction and calibration of a laboratory apparatus which combines light beams transmitted through colour filters in such proportions as to reproduce the intensity and energy distribution of all the coloured light signals generally used in practice. Part 2 discusses the technique of signal colour recognition and gives the results of over 40 000 observations in the form of charts on which are drawn contours of the frequency of recognition of the simple colours under different conditions of illumination, range of possible colours, etc. The significance of these contours is briefly discussed, with a view to stating physical limits within which signal colours should lie. Author.

X-RAYS.

2106. Quantum theory of X-ray reflection. C. V. Raman and P. Nilakantan. *Curr. Sci.*, **10,** *pp.* 241–245, *May*, 1941.—The modified X-ray reflections, having their origin in the quantum-mechanical excitation of the optical vibrations of the crystal lattice, are discussed. Low-temperature experiments with diamond indicate that the modified reflections cannot be due to the acoustic vibrations of the lattice. The Born diagram correctly represents only the acoustic phase space and cannot be applied to the optical phase space. Quantitative study of the (111) modified reflections of diamond for various orientations of the crystal, the plane of incidence coinciding with the plane of symmetry, indicates definitely that the reflections arise from the fact that the phase waves of the optical vibration have a definite orientation and azimuth with reference to the crystal planes. A. J. M.

2107. An experimental study of diffuse X-ray reflection by single crystals. K. Lonsdale and H. Smith. *Proc. Roy. Soc. A*, **179,** *pp.* 8–50, *Aug.* 29, 1941.—The present experimental study, illustrated by numerous photographs, consisted in taking Laue, oscillation and rotation photographs, in many different orientations, of inorganic and organic crystals belonging to various systems, using Cu, Mo and Ag radiations, unfiltered filtered or monochromatized. Rules are laid down for the indexing of diffuse spots and for the determination of the conditions under which such spots appear. Attention is drawn to the presence of non-radial streaks and to the difference in origin of these and of the more usual radial streaks. The relations of the intensity, shape, size, position and persistence, of the diffuse spots to the nature, structure, perfection, orientation and temperature, of the crystal examined, to the radiation used and to the conditions of photography, are considered in some detail. The use of diffuse spot patterns as a subsidiary method of crystal-structure determination is emphasized. It is pointed out that in reciprocal space each reflecting lattice point is surrounded by a region of diffuse scattering, whose physical significance is open to various theoretical interpretations. These diffusely reflecting regions are not, in general, spherical, but are extended along reciprocal lattice planes and axes. Authors.

2108. Secondary diffraction effect on Laue photographs of diamond. K. Lonsdale and H. Smith. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 529–531, *Sept.*, 1941.—Using a normal arrangement of apparatus, and X-rays from a Cu or Fe target, well-exposed Laue photographs of diamond sometimes show sharp diffraction curves around (111), (220) or (113) Laue spots. These curves are due to secondary diffraction by the black paper (light-tight) cover of the film-holder, and they only occur when the crystal is correctly set, to within ±0·3° for selective reflection of the characteristic $K\alpha$- or

β-radiation from one of these strongly reflecting diamond planes. This effect is a useful indication of correct crystal setting for monochromatization, and it also provides a measure of the width of the monochromatized beam. This secondary diffraction may introduce error in connection with intensity measurements, especially when long-wavelength radiation has been used. AUTHORS.

2109. Diffuse reflections of X-rays by crystals. C. G. DARWIN. *Proc. Roy. Soc. A*, **179,** *pp.* 65–66, *Aug.* 29, 1941.

2110. The effect of thermal vibrations on the scattering of X-rays. M. BORN AND K. SARGINSON. *Proc. Roy. Soc. A*, **179,** *pp.* 69–93, *Aug.* 29, 1941.—The structures discovered recently in the background of Laue photographs show a striking dependence on temperature. After discussing theories suggested by Raman and Nilakantan, and by Preston and Bragg, it is assumed that there can be no other explanation of this phenomenon than the effect of thermal vibrations, as first discussed by Debye. Formulae are derived representing the Laue spots and the background for any crystal as function of its structure and of temperature. These formulae are simplified by applying them to the case of the 3 cubic Bravais lattices; for the body-centred lattices one obtains an expression for the position of the spots which is identical with that given by Bragg, but with an additional law expressing the dependence of intensity on temperature. Approx. formulae are developed for all 3 cubic Bravais lattices which describe the position, shape and intensity, of the extra spots in the vicinity of Laue spots. AUTHORS.

2111. The diffuse spots in X-ray crystal photographs. W. H. BRAGG. *Proc. Roy. Soc. A*, **179,** *pp.* 94–101, *Aug.* 29, 1941.—The results of these experiments and of those in a previous paper [Abstr. 3168 (1940)] may be summed up in the statement that the positions and forms of the diffuse spots, so far as they have been observed, correspond closely to the geometry of the true diffraction patterns of the crystal, as calculated from first principles. The reverse is partly true: the calculated pattern shows places where diffuse spots might have been found and are not, but this does not negative the value of the correspondence that is observed. The question then arises: Why is it possible to use the diffraction formula to such effect? The formula would be applicable if there were in the crystal a sufficient number of small crystalline groups acting with some independence of each other. Any other explanation must describe a condition which simulates the effects of small groups so far as these effects have been observed. AUTHOR.

2112. New diffraction max. in Laue photographs. S. C. SIRKAR AND J. GUPTA. *Proc. Nat. Inst. Sci. India*, **6,** 4, *pp.* 705–712, 1940.—The qualitative theory put forward by Raman and Nilakantan [Abstr. 2663 (1940)] is examined and it is shown that there are some difficulties in the assumptions made. The observed facts contradict this theory, while the theory of diffuse scattering due to thermal vibrations of the lattices put forward by Zachariasen [Abstr. 2162 (1940)] explains satisfactorily all the facts observed by Raman and Nilakantan in the case of diamond. The angles made by the directions of max. in the diffuse scattering with the (111) planes for different angles of incidence agree closely with those calculated from Zachariasen's theory. The streamers radiating from the positions of the Laue spots due to (111) planes of diamond observed by Raman and Nilakantan are shown to be due to reflections in the planes of incidence of certain complicated planes in the zones (1*kl*, (*h*1*l*), and (*hk*1). AUTHORS.

2113. Sensitometry of roentgen film and interpretation of sensitometric data. G. C. HENNY. *Amer. J. Roentgenol. and Radium Ther.*, **45,** *pp.* 895–908, *June*, 1941.—The comparative suitability of photographic films for X-ray purposes is discussed with respect to film speed, contrast and latitude. Methods of test are considered, for which a rotating constant-speed shutter, with suitable graduated segments, is convenient, and variations which may occur in processing (development and fixation) are dealt with in detail. Plotting of characteristic curves and correction for fogging receive detailed treatment, together with methods of determining contrast and latitude of film, relationships between detail and contrast for radiographic film being brought out. B. J. L.

See also Abstract 2060.

HEAT.

CONDUCTION.

2114. Note on the theory of quenching. J. H. AWBERY. *J. Iron Steel Inst.*, [8 *pp.*], 1941. *Paper read at September meeting.*—The heat transfer to a fluid from the plane surface of a solid follows different laws according to the temperature of the surface. If this latter temperature is sufficiently far above the b.p. of the fluid, there is a régime in which a sheath of vapour forms between the solid and the fluid. It is shown that, during this régime, the heat loss H per unit area per second is $B(T_B - T_0)^{\frac{4}{3}}(k_l{}^2\alpha gc/\nu)^{\frac{1}{3}}$, where B is a constant, approx. 0·0015 if thermal quantities are measured in calories. The other symbols have the following meanings: T_B, b.p. of the fluid; T_0, temperature of the mass of the fluid; k_1, thermal conductivity of the fluid at the temperature $T' = (T_B + T_0)/2$; α, coefficient of cubic expansion of the fluid at temperature T'; g, acceleration due to gravity; c, sp. ht. of fluid per unit vol. at temperature $T' = (T_B + T_0)/2$; ν, cinematic viscosity of fluid at temperature T'. AUTHOR.

2115. Remarks on the analogy between heat transfer and momentum transfer. L. M. K. BOELTER, R. C. MARTINELLI AND F. JONASSEN. *Trans. Amer. Soc. Mech. Engrs*, **63**, *pp*. 447–454; *Disc*., 454–455, *July*, 1941. — [Abstr. 1302B (1941)].

FUSION AND SOLIDIFICATION.

***2116. Copper blocks and optical system for determining b.p. (Emich method) and m.p.** A. A. MORTON AND J. F. MAHONEY. *Industr. & Engng Chem*. (*Analytical Edition*), **13**, *pp*. 498–499, *July* 15, 1941.

2117. Statistical mechanics of fusion. J. G. KIRKWOOD AND E. MONROE. *J. Chem. Phys*., **9**, *pp*. 514–526, *July*, 1941.—A statistical mechanical theory of fusion based upon the use of local free energies is presented. An integral equation is formulated for the distribution function of average density in a region occupied by a system of molecules. Periodic solutions characteristic of a crystalline phase are found for certain ranges of values of a set of parameters depending upon temperature and volume. When the parameters decrease below certain critical values, all terms of the Fourier series representing the distribution function vanish with the exception of the constant term. A uniform density distribution characteristic of a fluid phase is then obtained. The melting parameters of argon at several pressures are calculated with the aid of the theory and compared with experiment. AUTHORS.

2118. Certain singular points on crystallization curves of solid solutions. N. L. BOWEN. *Proc. Nat. Acad. Sci., Wash*., **27**, *pp*. 301–309, *June*, 1941.—In many ternary systems 2 of the components form a complete series of solid solutions of the type with a min. melting temperature, while each of them forms a eutectic with the third component. A detailed survey of the theoretical courses of the curves of crystallization and the relation of fractional to equilibrium crystallization is given and discussed. N. M. B.

THERMOCHEMISTRY.

2119. The gap in the mixture of the system acetone-carbondisulphide. K. CLUSIUS AND W. RINGER. *Z. phys. Chem. A*, **187**, *pp*. 186–194, *Sept*., 1940. *In German*.—In tests on the mixing temperature of $(CH_3)_2$ CO and CS_2 a mixing gap is found below − 50°C. This was exactly measured. Special precautions were taken for filling the test phials free of air and humidity. The apparatus is described and illustrated. The upper critical solution temperature was found to be $-\,51{\cdot}3_8$°C. at 66·2 mol.% CS_2. R. N.

2120. Kinetics of thermal decomposition of oxalic acid in solutions. I. LÜTGERT AND E. SCHROER. *Z. phys. Chem. A*, **187**, *pp*. 133–148, *Sept*., 1940. *In German*.—Comparative tests were made on the decomposition of light oxalic acid in light water and heavy oxalic acid in heavy water for temperatures between 130° and 173°C. A time law of the first order was found. The decomposition of the heavy acid is about 20% faster. Activation heat is independent of temperature. The same increase in speed was found in parallel tests made on solutions of light and heavy oxalic acid in dioxan for temperatures between 120° and 150°C. Two possible explanations are given for the acceleration. Improved methods and appliances are described for carrying out the tests, especially for titration. R. N.

2121. Chemical equilibria of thermal associations. A. WASSERMANN. *Proc. Roy. Soc. A*, **178**, *pp*. 370–379, *July* 31, 1941.

2122. Two-phase equilibrium in binary and ternary systems. IV. The system ethane-propylene. H. LU, D. M. NEWITT AND M. RUHEMANN. *Proc. Roy. Soc. A*, **178**, *pp*. 506–525, *Aug*. 15, 1941. —The liquid-vapour equilibrium of the binary system ethane-propylene has been determined at a number of temperatures between − 30 and 70°C. and over a wide pressure range. From dew-point b.p. and p. v. t. measurements the $(P,\ T)_x$, $(T, x)_P$ and $(P, V)_{x,T}$ relationships for the pure hydrocarbons and for 9 mixtures have been determined. AUTHORS.

See also Abstract 2095.

THERMODYNAMICS.

2123. Equation of state of solid helium. G. KANE. *J. Chem. Phys*., **9**, *pp*. 568–570, *July*, 1941.

2124. Heat capacity of certain halomethanes. G. GLOCKLER AND W. F. EDGELL. *J. Chem. Phys*., **9**, *pp*. 527–529, *July*, 1941.—A semi-empirical method is based on additive contributions of the bonds and angles making up the molecule. Values obtained for 18 molecules at 3 temperatures by this method are compared with those calculated by statistical means. The average deviation is 0·9%. AUTHORS.

2125. Temperature effects with compressed air. A. L. EGAN. *Engineering*, **151**, *pp*. 444–445, *June* 6, 1941.—A consideration of the thermodynamics of the discharging and recharging of compressed air containers, having particular regard to the temperature changes produced under various conditions. R. W. P.

See also Abstracts 2122, 2138.

VAPORIZATION AND CONDENSATION.

***2126. Laboratory device for maintaining automatically constant humidity in a closed chamber.** C. Nanjundayya and N. Ahmad. *Proc. Nat. Inst. Sci. India*, **7**, 1, *pp*. 73–77, 1941.—The chamber consists of a water-proof box, into which a glass jet introduces l.p. steam, which in turn is generated by electrically heating water in a flask. A thermo-hygrograph acts as a control of humidity and operates a relay, which makes or breaks the current in the heating-coil circuit. A few dishes containing granulated $CaCl_2$ are kept inside the chamber to serve as a check on the efficiency of the humidity control. A small fan, placed in front of a gauze screen, serves to keep the air inside the chamber in circulation without disturbing the material under test. Authors.

***2127. Automatic device for recording moisture content of hygroscopic materials.** N. Ahmad. *Proc. Nat. Inst. Sci. India*, **7**, 1, *pp*. 79–87, 1941.—The material is kept in one arm of a balance, which is suspended with a fine wire into a chamber in which variations of humidity are brought about. A spiral spring serves to counterpoise the weight in the other arm, while a non-hygroscopic string tied to this arm and passing over a frictionless pulley is fastened to one end of a recording pen, which can oscillate freely in a vertical plane. The pen is kept close to a rotating drum, run by clockwork. A separate electric circuit containing a solenoid with a plunger and a timepiece, in which arrangement is made for hourly contact, moves a small carriage on a horizontal glass plate. Every time contact is made a vertical rod fixed to the small carriage presses the pen against the drum leaving a small dot. The friction of the pen against the drum is entirely eliminated and the apparatus can be calibrated to give variations in the weight of the material, its rate of absorption or desorption, time of lag, time of attaining equilibrium, etc. Author.

See also Abstract 2116.

ACOUSTICS.

2128. Heat conduction effects in sound emission. R. S. Alleman. *J. Acoust. Soc. Amer.*, **13**, *pp*. 23–25, *July*, 1941.—A mathematical formulation of the heat-conduction phenomena occurring at the surface of a sound emitter, wherein the medium considered to be receiving the sound and impeding the motions of the source is gas. The method is that previously used by Herzfeld [Abstr. 2965 (1938)]. The result is that, due to the rapid, approx. adiabatic, compressions and rarefactions, an alternating temperature gradient is set up in the solid source and in the medium in such a manner as to cause a reduction in the total amount of sound energy radiated from the source. This effect is expressed in terms of 2 out-of-phase components of particle velocity amplitude. The results had previously been applied in the revision of Hubbard's theory of the ultrasonic interferometer to take account of these heat conduction effects, and the experimental verification of the predicted reflection coefficients for several gases is taken as experimental justification of the theoretical synthesis given. Author.

2129. Frequency distribution of normal modes. G. M. Roe. *J. Acoust. Soc. Amer.*, **13**, *pp*. 1–7, *July*, 1941.—The formula obtained by Maa for the frequency distribution of the normal modes for a rectangular enclosure has been verified by a more direct computation and extended to apply to a cylinder, a sphere and a number of derived shapes. In all cases it is found that the number of normal modes with frequencies less than ν is given by $4\pi V\nu^3/3c^3+\pi A\nu^2/4c^2+\ldots$, where V is the volume and A the surface area of the enclosure. The application of this result is illustrated by a calculation of resonance response and rate of decay of sound in a cylinder. Author.

2130. Unmixing effect of sound waves on liquid mixtures. K. F. Herzfeld. *J. Chem. Phys.*, **9**, *pp*. 513–514, *July*, 1941.—The equations for sound waves passing through liquid mixtures are given. The amount of unmixing and the increase in sound absorption are calculated and found to be too small for observation. Author.

2131. Gravest mode of some vibrating systems. B. R. Seth. *Proc. Indian Acad. Sci. A.*, **13**, *pp*. 390–394, *May*, 1941.—Rayleigh's method for an approx. solution for the frequency of the gravest mode of vibration of certain systems, in which this mode gives an asymmetrical motion, is applied to the oscillations of water in a canal with sides inclined at an angle of 60° to the vertical.

The displacement in the gravest mode of transverse vibration of an isosceles triangular membrane is also worked out. G. C. McV.

2132. Velocity of sound in some binary alloys. G. E. ALLAN. *Phil. Mag.*, **32,** *pp.* 165–170, *Aug.*, 1941.—In alloys of Sn-Pb and of Zn-Sn the increase in the speed of sound is roughly proportional to the content of the first mentioned metal of the pair. In alloys of Cu-Zn and of Fe-Ni (with increase of the first mentioned metal) the velocity at first drops to a min. and thereafter increases in an irregular but somewhat similar manner in the two cases. In each pair the velocity is greater in the metal element with the lower atom. wt. G. E. A.

2133. Origin of the absorption of ultrasonic waves in liquids. K. F. HERZFELD. *J. Acoust. Soc. Amer.*, **13,** *pp.* 33–35, *July*, 1941.—The absorption of sound waves in water, benzene, carbon tetrachloride and methyl alcohol, is strictly proportional to (frequency)^2 up to 50 Mc./s., but considerably larger than can be explained by viscosity and heat conduction. It is shown here that an explanation of this increased absorption by slowness of energy exchange between internal and external degrees of freedom is not in disagreement with the facts for the 3 last-named liquids, while the absorption in water must have a different origin. AUTHOR.

2134. Absorption of ultrasonic waves in highly viscous liquids. J. L. HUNTER. *J. Acoust. Soc. Amer.*, **13,** *pp.* 36–40, *July*, 1941.—The absorption of ultrasonic waves in glycerin, castor oil, linseed oil and olive oil, was studied at various temperatures and at 3·1357 and 3·95 Mc./s., respectively. As the viscosity of the liquids used depends on the temperatures, the experiment permitted the calculation of the temperature coefficient of absorption and the results agreed within the experimental error with theoretical values. The sonic resonator interferometer developed by Hubbard, and adapted by Fox for use with liquids in this laboratory, was used. AUTHOR.

2135. Temperature and frequency effects on ultrasonic velocities in CO_2. C. J. OVERBECK AND H. C. KENDALL. *J. Acoust. Soc. Amer.*, **13,** *pp.* 26–32, *July*, 1941.—Ultrasonic velocity measurements in pure CO_2 gas were made at temperatures ranging from 25° to 530°C. with frequencies from 27 to 147 kc./s. Experimental variations published in earlier reports are traced to gas contamination and temperature gradient effects. Data are presented showing that the velocity is a function of both temperature and frequency. The velocity dependence on frequency becomes greater as the temperature is increased. This is due to an increased probability of the excitation of vibrational energy states as the temperature is raised. The results seem to show that the relaxation time for a transfer of energy from translational to vibrational states is longer than that for the transfer from translational to rotational states. AUTHORS.

2136. Theory of conical sound radiators. W. N. BROWN, JR. *J. Acoust. Soc. Amer.*, **13,** *pp.* 20–22, *July*, 1941.—An expression is derived for the sound pressure resulting from the vibration of a conical sound radiator and the sound field is compared with that generated by a plane piston. AUTHOR.

2137. Sound measurement room utilizing the "live-end dead-end" studio principle. M. D. STAHL AND W. C. LOUDEN. *J. Acoust. Soc. Amer.*, **13,** *pp.* 9–15, *July*, 1941.—The requirements of a suitable sound test room for the measurement and analysis of sound produced by household appliances are discussed. It is shown that neither the highly reverberant room nor the highly absorptive room will meet all requirements owing to the room resonant response of the former and the high sensitivity to directional effects of the latter. A sound room is described which makes use of a reflective floor, absorptive walls and a highly absorptive ceiling with the microphone placed near the ceiling. The sound source is moved in a reciprocating manner and a sound diffuser is rotated slowly during measurements to average out the space pattern effects. A high degree of sound reduction through the walls is achieved by massive construction and a large reduction of transmitted vibration is effected by a coil spring suspension. AUTHORS.

2138. Sound radiation pressure in liquids and gases in connection with the equation of state. G. HERTZ. *Phys. Z.*, **41,** *pp.* 546–549, *Dec.* 15, 1940. *In German.*—In the present paper a perspective picture is given of the processes leading to the phenomena of sound radiation pressure. The ground covered includes the Rayleigh sound pressure $(p_k - p_o)$ and the Langevin $(p_k - p_w)$, in which p_o = pressure of the medium at rest, p_k = pressure on the piston, p_w = pressure on the side wall of the tube; observed pressures as temporal mean values; construction of the pressure distribution in a wave; connection with the equation of state; sound pressure with supersonic waves in liquids. [See Abstr. 2192 (1940)]. H. G. S.

***2139. Continuously variable acoustic impedance.** E. C. JORDAN. *J. Acoust. Soc. Amer.*, **13,** *p.* 8, *July*, 1941.

2140. Theatrical uses of the remade voice, subsonics and reverberation control. H. BURRIS-MEYER. *J. Acoust. Soc. Amer.*, **13,** *pp.* 16–19, *July*, 1941.

2141. The comma in music. A. F. DUFTON. *Phil. Mag.*, **32,** *pp.* 259–261, *Sept.*, 1941.

2142. Tone synthesis with the toothed-wheel generator. K. H. KLEINE. *Phys. Z.*, **42,** *pp.* 111–116, *April*, 1941. *In German.*—By electrostatic or magnetic pick-up from a toothed-wheel generator the wave form depends on the shape of the teeth and on the distance of the pick-up. The author has utilized this principle in the construction of a synthetic tone generator in which the air gap is controlled so that it is possible to produce tones of varying wave form, transient overtones, etc. The incisiveness of percussion instruments can be imitated and the tone is both in timbre and dynamics closer to that of ordinary musical instruments than is otherwise possible with electronic instruments. The apparatus is described and illustrated and oscillograms of wave forms for different tooth shapes and air gaps are given. ED.

2143. Solid iris diaphragms. R. S. CLAY. *J. Sci. Instrum.*, **18,** *pp.* 190–191, *Sept.*, 1941.—A type of iris diaphragm is described in which the members which close the aperture are made of solid plates instead of the usual leaves of thin metal. The application to an adjustable spanner, either square or hexagonal, is illustrated. AUTHOR.

See also Abstract 1962.

ELECTRICITY AND MAGNETISM.

CONDUCTION AND DISCHARGE IN GASES.

2144. High-frequency discharges through gases. Y. ASAMI. *Rep. Radio Res., Japan*, **10,** *pp.* 1–10, *Nov.*, 1940.—[Abstr. 1342B (1941)].

2145. Production, properties and applications to micro-analysis of arcs possessing large area anode spots. E. W. FOSTER. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 594–613, *Sept.*, 1941.—Factors influencing the area of hot spots are briefly discussed. Experiments are described in which an arc is struck in air at atmospheric pressure between a graphite cathode and a graphite anode—in the form of a cup at the end of a thin pillar. The cup is filled with powdered graphite which has been impregnated with a small amount of one of several suitable alkali and alkaline earth salts. At first a localized spot appears at each electrode, but after a short time, t_s, the anode spot rapidly extends until it covers the surface of the powder. This new and stable condition is maintained for a period t_b, usually $> t_s$, until the supply of salt becomes exhausted (wholly by evaporation through the arc under suitable conditions), when the anodic spot again becomes localized. The anode cup is then usually at a temperature between 800° and 2 000°C. t_s and t_b depend on the amount and nature of the salt, on the anode dimensions and on the arc current. The relation between t_s and t_b and the other variables has been studied experimentally. Results are shown graphically and a theory to account for some of these and other observations is proposed. Conditions permitting a satisfactory general spectrographic system of quantitative microchemical analysis for mineral matter are discussed in the light of recently acquired knowledge of the arc and the new observations. A new method of analysis is suggested. Reasons for believing that the necessary conditions could be satisfied are given. Results obtained with a crude (and for rough work useful) approximation to this method are satisfactory. The limiting sensitivity for Ag is in the neighbourhood of 10^{-9} g. AUTHOR.

2146. Measurement on Hg impulse discharges at higher pressures. R. ROMPE AND P. SCHULZ. *Phys. Z.*, **42,** *pp.* 105–110, *April*, 1941. *In German.*—[Abstr. 1425B (1941)].

2147. Importance of gas in electrodes for the glow-to-arc transition. F. A. MAXFIELD, H. R. HEGBAR AND J. R. EATON. *Trans. Amer. Inst. Elect. Engrs*, **59,** *pp.* 816–821; *Disc.*, 1095–1096, 1940.—[Abstr. 1344B (1941)].

2148. Electrical discharges from pointed conductors. J. ZELENY. *J. Franklin Inst.*, **231,** *pp.* 23–37, *July*, 1941.—The general properties of, and the current/voltage relationship in, electrical discharges from points are discussed. The current/voltage relationship is often erratic at the beginning of the discharge. This is particularly so in the case of negative discharges. The nature of the negative and positive discharges is described. The discharge from points in Geiger-Müller counters is discussed. The abrupt change in the current/voltage curve for positive discharges near the onset of the discharge, which was formerly observed, was due to the type of galvanometer used, and was therefore spurious. The effect of external ionization of the space before the passage of the discharge is described. In the case of a positively charged point, when a strong radioactive source is brought up, a large current flows at voltages just below the min. starting potential, but ceases when the source is removed. When, however, the min. starting potential is exceeded, the current continues to flow even though the radioactive source is removed, but it drops to the value it would have had in the absence of the source. In the case of a negatively charged point the saturation current due to the ions produced by the radioactive source remains practically the same as the potential of the point is raised, until this reaches a certain value, at which there is a sudden, considerable increase in the current. An explanation of the different behaviour of the 2 points is given. A. J. M.

2149. Observation on the theory of the arc discharge. R. SEELIGER. *Phys. Z.*, **42,** *pp.* 63–67, *March,* 1941. *In German.*—Concerns the two theories of the arc discharge with metals of low boiling points such as Cu and Hg—the Langmuir "field" arc theory and the Slepian theory of a thermal ionization of the gas or vapour next to the cathode. The formulae of an earlier article [Abstr. 801 (1936)] are extended by combining them with the field emission formula in view of the recent work by Haefer [*Z. f. Phys.* **116,** *p.* 604, 1940]. The two models of the earlier work are taken. In model I the electrons and ions are assumed free to traverse the region of the cathode fall. In model II the electrons are free to traverse this region, but the ions, on the other hand, lose their entire energy with each gas-kinetic collision. The conclusion is reached that the mechanism of the cathode fall cannot be interpreted by the "field" arc theory and that the correct way of dealing with the Slepian theory is that proposed previously [Abstr. 2207 (1940)]. H. G. S.

2150. Recent sources of ions. H. KORSCHING. *Phys. Z.*, **42,** *pp.* 74–79, *April,* 1941. *In German.*—In this report the ion sources discussed are canal-ray tubes, arc discharge with separately heated cathodes, capillary arcs, production of ions by crossing electron and atom rays, and production of ions by oscillating electrons. The earlier report [Abstr. 1518 (1937)] is cited. H. G. S.

CONDUCTION IN SOLIDS AND LIQUIDS.

2151. Electrical and optical behaviour of semiconductors. XV. Electrical measurements on lead selenide. K. BAUER. *Ann. Phys., Lpz.*, **38,** 1, *pp.* 84–98, 1940. *In German.*—[Abstr. 5468 (1937)]. Conductivity, Hall effect and thermo-effect, of PbSe have been investigated. The material was normally produced by reaction between Pb powder and Se powder, followed by melting and slow cooling of the pulverized product. A macro-crystalline PbSe resulted; single crystals of about 1 cm.^{3} could be grown by crystallizing the material *in vacuo* from the melt. PbSe in stoichiometric composition showed already a high conductivity of 10 Ω^{-1}/cm. cube. Excess of Pb or of Se increased the conductivity up to 1 200 in the case of Pb, or up to 2 300 Ω^{-1}/cm. cube in the case of Se. Only the plates of lowest conductivity showed a slight decrease of resistance with increasing temperature. Moderate excess of Se produced a positive temperature coefficient as in Fe; a great excess of Se or excess of Pb made the increase in resistance with temperature less steep, but it remained larger than that of pure Pb. The conductivity of the test plates could be changed by heat treatment *in vacuo* or in Se vapour, according to their original composition as reduction or oxidation semiconductors. The Hall constant was practically independent of temperature; the product of this constant and of the conductivity gave an unusually high mobility between 150 and 1 370 cm.^{2}/V sec. The thermo-voltage changed its sign with treatment like the Hall constant, reaching about 300 μV/deg. against Bi. A. v. H.

XVI. Electrical measurements on lead sulphide. L. SISENMANN. *Ann. Phys., Lpz.*, **38,** 2, *pp.* 121–138, 1940. *In German,*—The conductivity, Hall effect and thermo-electric force, of PbS samples of different origin were measured, as well as the influence of oxidation and reduction. On heating in vacuum and in S vapour, respectively, changes of conductivity of 10–1 000 Ω^{-1}/cm. cube, of the Hall constant of $-0{\cdot}4$ to $+12$ cm.^{3}/A sec., of thermo-electric constant of -300 to $+100\,\mu$V/deg. were reached. Beatty's rule was always obeyed. The contradictions found in the literature are thus explained. The results on synthetic materials agree with those for natural substances. M. S. V.

2152. Derivation of the principle of electromagnetic equivalence from Laplace's law. E. PERSICO. *Rev. Univ. nac. Tucumán A,* **1,** 1 *and* 2, *pp.* 63–65, 1940. *In Italian.*—The author shows that a series of substitutions in the vectorial expression for Laplace's law leads to an expression for the potential of a double layer, thus proving the equivalence of a current to a magnetic shell. ED.

2153. Contribution to the aromatic problem. Density distribution and zero-point energy of the conduction electrons of graphite. O. SCHMIDT. *Phys. Z.*, **42,** *pp.* 36–45, *Feb.* 15, 1941. *In German.*—The mean value of the density of the *B*-electrons in the base-plane of the graphite layer is $17{\cdot}6\times10^{22}$ greater than in any known metal. The mean zero-point energy of the *B*-electrons with 6·8 eV has the value of the max. zero-point energy of Cu (7 eV). The *B*-electrons of graphite are thus free, in agreement with the effective number of the conduction electrons derived on the basis of the sublimation heat. In these considerations an important point is the assumption of the axial quantum number 1 for the ground state and 2 for the excited state. As graphite is the prototype of all aromatics these considerations apply also to benzol. An essential difference is thus indicated from the benzol theory of Hückel which, in the ground state, gives for the Ψ-functions of the *B*-electrons a nodal plane in the plane of the C atoms. 58 references are given. H. G. S.

2154. Determination of the residual current of an ionization chamber and the true conductivity of dielectric liquids. A. ROGOZINSKI. *Phys. Rev.*, **60,** *pp.* 148–152, *July* 15, 1941.—In an ionization chamber containing a dielectric liquid the residual current can be practically identified with the true conductivity of the liquid. It is found that, in the case of liquid hexane, the residual current amounts only to $\frac{1}{8}$ of the total current. AUTHOR.

*2155. **Note on d.c. characteristics of the string galvanometer.** F. T. ROGERS, JR. *Rev. Sci. Instrum.*, **12,** *pp.* 351–354, *July*, 1941.—A useful fifth-degree equation is derived for the d.c. behaviour of the string galvanometer; it contains 7 parameters, 3 for the (symmetric) magnetic field, 3 for the (elastic) suspension, and 1 for the length of the string. Examples and a discussion are given concerning the practical use of this equation. AUTHOR.

*2156. **Integrator for small currents.** B. E. WATT. *Rev. Sci. Instrum.*, **12,** *pp.* 362–365, *July*, 1941.—A current integrator employing a neon bulb has been used; it is found to require no correction of any kind, and to be independent of power-supply fluctuations. The lowest current for which the integrator can be considered reliable is 0·05 μA. Currents up to 30 μA have been integrated properly, and it is believed that currents up to 200 μA could be integrated by a similar circuit. AUTHOR.

2157. Deviations from Ohm's law in semiconductors. W. SCHOTTKY. *Phys. Z.*, **41,** *pp.* 570–573, *Dec.* 15, 1940. *In German.*—[Abstr. 1395B (1941)].

DIELECTRICS AND CAPACITANCE.

2158. On the theory of residual phenomena in dielectrics. B. GROSS. *Rev. Univ. nac. Tucumán A*, **1,** 1 *and* 2, *pp.* 35–47, 1940. *Publ. Fac. Cienc. Fis.-Mat., La Plata*, **11,** *pp.* 33–48, *April*, 1941. *In Portuguese.*—[Abstr. 1338B (1941)].

2159. Theory of solid insulators. F. MÖGLICH AND R. ROMPE. *Naturwissenschaften*, **29,** *pp.* 105–113, *Feb.* 21 *and pp.* 129–134, *Feb.* 28, 1941. *In German.*—The authors consider the electron gas and lattice structure in relation to solid insulators, for which they have already shown [*Z. Phys.*, **115,** *p.* 707, 1940] that this 2-part division is tenable provided that the reciprocal action of the part-system is taken sufficiently into account. They have also elucidated a series of phenomena hitherto not amenable to simple interpretation [Abstr. 1397 (1941)]. These points are dealt with in the present paper, the subject matter comprising: optical properties, the band model, the Schön-Riebl model of a luminous phosphor, reciprocal action with the lattice, single collisions, multiple collisions, luminescence of selective radiators, complicated phenomena with luminous phosphors, excitation of luminescent matter by cathode rays and α-rays. In their preamble they reject the supposition, often tacitly made, that electron gas and lattice structure are always to be regarded as loosely coupled systems. The coupling depends largely on the temperature of the lattice structure and on the electron energy, and, at times, the coupling is so tight that the 2 parts can no longer be regarded as separate structures. H. G. S.

2160. On the dielectric strength of mixed crystals. H. FRÖHLICH. *Proc. Roy. Soc. A*, **178,** *pp.* 493–505, *Aug.* 15, 1941. *Based on Rep. of the Brit. Elect. Allied Industr. Res. Assoc.*—[Abstr. 1341B (1941)].

2161. Dielectric constant and effective dipole moment of drying oils. B. P. CALDWELL AND H. F. PAYNE. *Industr. Engng Chem.*, **33,** *pp.* 954–960, *July*, 1941.—The dielectric constants of raw and heat-bodied linseed, perilla, tung and oiticica oils, were determined by 2 methods: Schering bridge at 60 c./s. and resonance at 45–60 Mc./s. The effective dipole moments were calculated by Debye's equation. The orientation polarization was obtained as the difference between the molar polarization and refraction. The values are plotted against viscosity and mol. wt. Relatively small differences were obtained between linseed, perilla and tung, although these oils contain non-conjugated and conjugated structures, but a large increase in polarity resulted from the ketonic group in oiticica. Mixtures of tung with linseed or perilla may be identified by refractive-index measurements, but this method of identification is not satisfactory for tung with oiticica. Mixtures of the latter may, however, be identified by density and also by dielectric-constant measurements. The rapid resonance method was applicable for mixtures of tung and oiticica, and the variation in dielectric constant with composition was found to be linear. The dielectric constant of the oils investigated varied considerably with frequency, the variation in general being greater, the higher the viscosity of the oil. AUTHORS.

See also Abstract 2191.

ELECTROCHEMISTRY.

2162. Mobile battery supply unit for laboratory and workshop use. A. M. ARMOUR. *J. Sci. In-*

strum., **18**, *pp.* 184–188, *Sept.*, 1941.—[Abstr. 1336B (1941)].

2163. Fluidity of electrolytes. E. C. Bingham. *J. Phys. Chem.*, **45**, *pp.* 885–903, *June*, 1941.—The fluidity of a dilute electrolyte is obtained as the sum of the fluidities of the solvent, the ions and the undissociated solute molecules. Electrolytes whose molecular elevations are greater than zero are by definition all more fluid than water and do not crystallize out of water with water of crystallization; they have low or negative heat of solution and the ions are comparatively little hydrated. In every known case an acid salt has a higher fluidity than the corresponding normal salt, even when the cation of the latter has a positive ionic elevation tending to raise the fluidity, and this can only partly be explained by hydrolysis. In general, the higher the valence of the ion the lower the ionic elevation. Molecules of undissociated electrolyte are more fluid than the ions derived from them, e.g. H_2O, $CdCl_2$ and $HgCl_2$. In the case of salts of polybasic acids the different radicals, such as SO_4^- and HSO^-_4, have quite different values characteristic of entirely unrelated ions. The strongest acids and bases are in general the most fluid. The ionic elevation varies directly as the concentration in dilute solution, and the decrease in ionic elevation with temperature rise is explained by lessening of hydration. Rise of fluidity is due to the breaking down of association in the water itself, caused by the presence of the salt. H. H. Ho.

2164. Electrolytic deposition of Pb from biological material. K. Bambach and J. Cholak. *Industr. Engng Chem.* (*Analytical Edition*), **13**, *pp.* 504–505, *July* 15, 1941.—In a new method for the electrolytic deposition of traces of Pb from biological material the solution of the ashed sample is electrolysed directly, without previous separation of the Pb. Authors.

*2165. **Modification of Pregl's apparatus for electro-deposition.** A. J. Llacer, J. A. Sozzi and A. A. Benedetti-Pichler. *Industr. Engng Chem.* (*Analytical Edition*), **13**, *pp.* 507–508, *July* 15, 1941.—A modification of Pregl's apparatus for the quantitative micro-determination of metals by electro-deposition permits quantitative collection of electrolyte and washings in an efficient and simple manner. The apparatus was applied to the separation of Cu and Ni previous to their determination in German silver. Reasonably satisfactory results were obtained when 5 g. of the alloy were dissolved, and the micro-analyses were performed on small portions of the solution. The alloy was not sufficiently homogeneous to give representative samples of 5 to 10 mg. wt. when single small shavings were taken for analysis. Authors.

2166. Studies in hydrogen overvoltage at high current densities. V. The decay of hydrogen overvoltage. A. Hickling and F. W. Salt. *Trans. Faraday Soc.*, **37**, *pp.* 450–460; *Disc.*, 460–462, *Sept.*, 1941.—[See Abstr. 1908 (1941)]. The decay of hydrogen overvoltage upon interruption of the polarizing current has been studied at 18 electrodes by a new method which permits of observation of the process from a min. time of 5×10^{-5} sec. Two distinct processes are involved in the decay. One, which becomes operative only at C.D.'s greater than 10^{-3} A/cm.^{2}, leads to a rapid drop of potential in the first msec. and depends primarily upon the polarizing C.D. used; this process occurs at lower C.D.'s with the electrodes which show deviations from Tafel's equation, but is common to practically all the electrodes at a sufficiently high C.D. At all C.D.'s there exists a second process, resulting in a slower decay of overvoltage, which follows a course such that, after a time which is greater the lower the polarizing C.D., the overvoltage becomes proportional to the log of the time; when this state is reached, the rate of decay depends solely upon the nature of the electrode material. The discussion of these results in the light of current theories of overvoltage is considered, and it is concluded that these views are inadequate for the description of the phenomena observed. Authors.

2167. Effect of the chemical durability of glass on the asymmetry potential and reversibility of the glass electrode. E. H. Hamilton and D. Hubbard. *Bur. Stand. J. Res. Wash.*, **27**, *pp.* 27–32, *July*, 1941.—Departures from a linear relation between the voltage of the glass electrode and the *p*H of alkaline solutions were approx. proportional to the amount of attack on the glass by the solution, as measured by the interferometer. The departures were less before than after the electrode had been immersed in a highly alkaline solution, and the drift of the potential at a constant *p*H was most marked with high alkalinity, indicating that non-reproducibility of voltage was associated with chemical attack on the glass. Differences in the capacities of the two surfaces of electrode bulbs of Corning 015 glass to absorb ions, as shown by the absorption of an organic dye, may be the cause of asymmetry potential. Authors.

ELECTRONS, NEUTRONS, POSITRONS AND PROTONS.

2168. The electronic charge. V. D. Hopper and T. H. Laby. *Proc. Roy. Soc. A.*, **178**, *pp.* 243–272, *July* 31, 1941.—The determination of *e* by a new oil-drop method in which the electric field is horizontal is described. The expression for

e in terms of quantities measured is similar to that which applies to H. A. Wilson's method. The correction for the departure from Stokes's law is obtained from Millikan's relation. The oil drops used are larger than those used by previous experimenters, and their velocity of fall and the velocity in the direction of the electric field could be estimated with satisfactory accuracy. Assuming $\eta_{23} = 1\,830 \times 10^{-7}$ c.g.s. unit, the value of e obtained is $(4{\cdot}8\,020 \pm 0{\cdot}0\,013) \times 10^{-10}$ e.s.u. The probable error calculated by least squares is about 1/3 of that obtained by Millikan. The errors in the determination of η_{23} by the rotating-cylinder and the capillary-tube method are discussed and the final mean $\eta_{23} = (1\,830{\cdot}06 \pm 2{\cdot}5) \times 10^{-7}$ c.g.s. is derived. This contributes an error of 1 : 500 in e and is its major uncertainty by the oil-drop method. Recent determinations of the electronic charge by the X-ray method are analysed. The mean value of e by this method is $(4{\cdot}8\,044 \pm 0{\cdot}0\,007) \times 10^{-10}$ e.s.u., and this result differs from the mean of the determinations of Millikan and the authors $(4{\cdot}8007 \pm 0{\cdot}002) \times 10^{-10}$ e.s.u. by $0{\cdot}0037 \times 10^{-10}$ e.s.u., which is less than the error due to the viscosity of air. Assuming the X-ray value of e, the viscosity of air can be deduced and is found to be $(1\,830{\cdot}9 \pm 0{\cdot}5) \times 10^{-7}$ c.g.s. unit at 23°C. AUTHORS.

2169. Methods and results of recent research in nuclear physics. G. HOFFMANN. *Phys. Z.*, **41,** *pp.* 514–522, *Dec.* 15, 1940. *In German.*—A survey of some of the methods and main results of recent research in nuclear physics—nuclear masses, moments, forces and processes; the cyclotron; H^3; He^3; splitting of uranium; the meson; electron showers. H. G. S.

2170. Nuclear magnetic moments of C^{13}, Ba^{135} and Ba^{137}. R. H. HAY. *Phys. Rev.*, **60,** *pp.* 75–86, *July* 15, 1941.—The nuclear gyromagnetic ratios for C^{13}, Ba^{135} and Ba^{137} have been measured by the molecular-beam magnetic-resonance method. The signs of the nuclear magnetic moments have also been determined. For C^{13} the g value is $1{\cdot}402 \pm 0{\cdot}004$ and the moment is positive. When this fact is considered with the results of theoretical treatments of the C^{13} nucleus, $I = \frac{1}{2}$ seems to be the preferable value for C^{13}. The resultant nuclear magnetic moment is $+0{\cdot}701 \pm 0{\cdot}002$ n.m. The moments for both Ba^{135} and Ba^{137} are positive. The g values are $0{\cdot}5575 \pm 0{\cdot}0017$ and $0{\cdot}6236 \pm 0{\cdot}0019$, respectively. Using $I = \frac{3}{2}$ for both nuclei, the corresponding nuclear magnetic moments are $+0{\cdot}8363 \pm 0{\cdot}0026$ and $+0{\cdot}9354 \pm 0{\cdot}0029$, respectively. The ratio of the moments is $1{\cdot}1174 \pm 0{\cdot}0010$. All g values are referred to that for Li^7 of 2·1688. Careful examination of the Ba beam intensity as a function of homogeneous field strength with constant oscillating field frequency revealed only 2 resonance minima. AUTHOR.

2171. On the precision measurement of nuclear magnetic moments by the molecular-beam magnetic-resonance method. The moments of H^1, Li^7, F^{19}, and Na^{23}. S. MILLMAN AND P. KUSCH. *Phys. Rev.*, **60,** *pp* 91–100, *July* 15, 1941.—A direct comparison of nuclear magnetic moments with the electronic moment is made. This is done by the measurement of the Larmor precession frequency of the nucleus and the frequencies of some of the lines of the r.f. spectra of the alkali atoms in the same magnetic field. In this way the magnetic moment of the proton is found to be $2{\cdot}7896 \pm 0{\cdot}0008$ nuclear magnetons. The precision of this value is much greater than that obtained by usual methods. The same methods are used in a redetermination of the magnetic moments of Li^7, F^{19} and Na^{23}. Since the nuclear gyromagnetic ratio of Li^7 has previously served as a standard in terms of which other g values were expressed, an improvement in the precision of this g value makes it possible to restate, with improved precision, the g values and magnetic moments of other nuclei. AUTHORS.

2172. On electronic g factors for alkali atoms. M. PHILLIPS. *Phys. Rev.*, **60,** *pp.* 100–101, *July* 15, 1941.—Possible theoretical deviations from $g_J = 2$ for the ground state of the alkalis are investigated, and it is concluded that none is large enough to affect measurably the experimental results. AUTHOR.

2173. Difficulties in the field theory of exchange forces. E. C. G. STÜCKELBERG. *Phys. Z.*, **41,** *pp.* 523–524, *Dec.* 15, 1940. *In German.*—It is shown that the so-called Yukawa potential does not follow from the Yukawa theory with exchange of electric charge and spin moment but a much more complicated system of forces (multi-particle forces). H. G. S.

2174. Nuclear spectra of light elements on the photographic plate. O. MEERHAUT. *Phys. Z.*, **41,** *pp.* 528–532, *Dec.* 15, 1940. *In German.*—The photographic method, its operation and accuracy, are briefly discussed. The new photographic plates of thicknesses up to $100\,\mu$ specially prepared for work on nuclear physics enable the range of high-speed protons to be measured with comparative facility. The proton distribution in Al, Na, P and B, are measured, and for each element tables are given of the ranges and energy values obtained as well as range-distribution curves of the protons. The experiments are being continued. H. G. S.

2175. Dependence of the secondary electronic emission produced by γ radiation upon the direction of the radiation. C. W. WILSON. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 613–623, *Sept.*, 1941.—Experiments are described which show that the electronic emission from a sheet of material, due to γ-radiation, depends upon the direction of the radiation with respect to the sheet. In certain directions the emission from a sheet of material is equivalent to that from a sheet of "air-wall" material (graphite). An approx. explanation of these findings is given. An examination of the electronic emission from bone, when it is irradiated with γ-radiation, indicates how the energy absorption per röntgen of γ-radiation may change at boundaries between bone and soft tissues. AUTHOR.

2176. Behaviour of electrons in oxygen. R. H. HEALEY AND C. B. KIRKPATRICK. *Amal. Wireless* (*Aust.*) *Techn. Rev.*, **5**, 4, *pp.* 155–164, 1941. —[Abstr. 1442B (1941)].

2177. Measurements on hard H-rays. W. JENTSCHKE. *Phys. Z.*, **41,** *pp.* 524–528, *Dec.* 15, 1940. *In German.*—A double ionization-chamber method enabling simultaneous measurements to be made of the ionization and range of energy-rich H-rays is briefly described. An integral and a differential ionization curve are given for single protons in air at 15°C. and 760 mm. pressure for a range up to 70 cm. The range of the longest H-ray group produced by bombardment of B with Po α-rays is measured and amounts to 94 cm. With the method used these long rare H-rays can be clearly distinguished from α-rays present. H. G. S.

2178. Scattering of slow neutrons by molecular gases. R. G. SACHS AND E. TELLER. *Phys. Rev.*, **60,** *pp.* 18–27, *July* 1, 1941.—It has been shown by Fermi that the cross-section for the scattering of slow neutrons by protons is 4 times greater for protons strongly bound to an infinite mass than it is for free protons initially at rest. A simple generalization of this factor of 4 can be given for the scattering of neutrons by molecular gases if the neutron energy is great as compared with the energy differences of the rotational levels of the scattering molecule but small compared with the quanta of molecular vibration. In this case the proton may be replaced by a freely moving hypothetical mass point whose mass is a tensor depending on the mass and structure of the molecule. On this basis the total cross-section for the scattering of slow neutrons by H_2, and by CH_4, NH_3 and H_2O at low temperatures, has been calculated as a function of the ratio of the neutron energy to the thermal energy of the scattering gas. The possibility of applying the theory to a determination of the neutron-proton scattering cross-section is discussed. AUTHORS.

2179. Scattering of 1eMV to 3eMV protons by He. N. P. HEYDENBURG AND N. F. RAMSEY. *Phys. Rev.*, **60,** *pp.* 42–46, *July* 1, 1941.—The scattering of protons of from 1 to 3eMV energy by He has been experimentally examined for the existence of resonance scattering analogous to the neutron-helium resonance observed for 1eMV neutrons by Staub and Stephens. If *n-n* and *p-p* nuclear forces are equal, such a resonance should occur in *p*-He scattering for protons of approx. 2eMV. The number of protons scattered through 140° were observed as a function of their energy. This number passed through a max. at 2eMV as expected, but the sharpness and height of the max. were several times less than for the *n*-He resonance. However, this greater width and lesser intensity can be qualitatively justified. The number of protons scattered through 76° did not show the presence of a resonance scattering as the energy was varied. Observations of the angular distribution of the scattered protons for angles of scattering between 30° and 140° for proton energies of 1·0, 1·5, 2·0, 2·5 and 3·0 eMV, respectively, have been obtained. AUTHORS.

2180. Resonance energy of the Th capture process. L. MEITNER. *Phys. Rev.*, **60,** *pp.* 58–60, *July* 1, 1941.

2181. A new method for measuring the energy distribution of secondary electrons. R. KOLLATH. *Phys. Z.*, **41,** *pp.* 576–579, *Dec.* 15, 1940. *In German.*—After a brief review of the most important results of measurements of the energy distribution of secondary electrons and of the methods employed, the opposed field and the transverse magnetic field, the principle of the method of the longitudinal magnetic field, which possesses certain advantages over them, is explained. The most important details of the apparatus used are described, and curves of the secondary electron energy distribution from some measurements by the method, made with Ta, Mo and Be, both before and after annealing, are discussed. [See Abstr. 1664 (1941)]. H. G. S.

2182. Electron-lens type of β-ray spectrometer. C. M. WITCHER. *Phys. Rev.*, **60,** *pp.* 32–42, *July* 1, 1941.—A β-ray spectrometer utilizing the focusing action of the homogeneous magnetic field produced by a long solenoid is described. The theory of the action of an instrument of this type is considered in some detail for the case of a point source of β-rays, and the extension of the theory to cover the case of an actual source of finite area is discussed. Details of design are given, together with a number of experimental tests which have been made on the instrument. These tests include measurements of the absorption of β-rays in the cellophane window of the G.M. counter used for detection, measurement of the resolution and efficiency of the spectrometer, calibration of the instrument, and an examination of the β-ray spectrum of radium E. The β-spectra of ${}_{15}P^{32}$ and ${}_{77}Ir^{194}$ have been investigated. AUTHOR.

2183. Determination of the resolving power of electron microscopes. M. VON ARDENNE. *Phys. Z.*, **42,** *pp.* 72–74, *March,* 1941. *In German.*—After referring to the usual method of determining the resolving power the author describes his method of making electron microscope test preparations by the formation of wedge-shaped films of the metal evaporated in a vacuum on a thin collodion membrane. The results obtained with the method are given, and it is shown that the resolving power of the universal electron microscope [Abstr. 2257 (1940)] is 2·2 mμ. H. G. S.

2184. Acceleration of electrons by magnetic induction. D. W. KERST. *Phys. Rev.*, **60,** *pp.* 47–53, *July* 1, 1941.—Apparatus with which electrons have been accelerated to an energy of 2·3 eMV by means of the electric field accompanying a changing magnetic field is described. Stable circular orbits are formed in a magnetic field, and the changing flux within the orbits accelerates the electrons. As the magnetic field reaches its peak value, saturation of the iron supplying flux through the orbit causes the electrons to spiral inward toward a tungsten target. The X-rays produced have an intensity approx. equal to that of the γ-rays from 1 g. Ra; and, because of the tendency of the X-rays to proceed in the direction of the electrons, a pronounced beam is formed. AUTHOR.

2185. Electronic orbits in the induction accelerator. D. W. KERST AND R. SERBER. *Phys. Rev.*, **60,** *pp.* 53–58, *July* 1, 1941.—A general account of the principles of operation of the electron induction accelerator and detailed analysis of the orbits of the electrons, to serve as a guide in the design of the accelerator. AUTHORS.

See also Abstracts 1968, 1980, 2060, 2191, 2192.

ELECTROSTATICS.

2186. Contact electrification of solid particles. R. SCHNURMANN. *Proc. Phys. Soc., Lond.*, **53,** *pp.* 547–553, *Sept.,* 1941.—Solid particles carry with them electrostatic charges from contact with the storage vessel. The sign of the charge acquired in the air of the laboratory was determined for metal particles which were poured either from a silica bowl or from a glass beaker, and for particles of insulators and semi-conductors which parted contact with containers of silica, glass or various metals. A closed, insulated metal funnel which is connected to an electroscope receives the charge which the particles carry with them from contact with a container from which they are poured. When the particles are made to stream from the funnel after the electrostatic charge has been removed from it, the funnel again acquires a certain charge, while the particles carry the opposite charge with them to the receptacle. Copper filings poured from a container of either glass or silica assume a positive charge, and silica particles poured from a copper trough assume a negative charge, while silica in bulk assumes a positive charge when it is rubbed against copper in bulk. Sb powder poured from a container of either glass or silica assumes a negative charge, and both glass and silica in bulk rubbed against a block of Sb assume a positive charge. AUTHOR.

GALVANOMAGNETIC AND THERMOMAGNETIC EFFECTS.

2187. Resistance increase in magnetic fields and conduction types of the metals. E. JUSTI. *Phys. Z.*, **41,** *pp.* 563–570, *Dec.* 15, 1940. *In German.*—After a review of the theory of the free isotropic electron gas and its failure to explain galvanomagnetic effects a summary is given of the work carried out in the low-temperature research laboratory of the Physikalisch-Technische Reichsanstalt on the change of electrical resistance in the transverse magnetic field. This work has made clear the primary importance of the metal ion crystal lattice for the occurrence of resistance, whereby collision anisotropy and bond anisotropy play a part. The universal theory of the free isotropic electron gas must in consequence be abandoned and in its place a law of types developed for metals. The proof of this law of types is to be found in the reduced Kohler diagram $\log(\Delta\rho_{H,T}/\rho_{H-0,T}) = \log[f(H/r_T)]$. It depends on the Kohler rule [Abstr. 2617 (1938)] according to which the relative resistance changes, determined azimuthally, independent of greater changes of H (magnetic field), T (temperature) and Z (residual resistance) lie on a single curve when they are plotted as functions of H/r_T. The limits of validity of the rule are explained experimentally and theoretically. The reduced diagram, in which, by transition from $r_{T^\circ} = R_{T^\circ}/R_{273^\circ}$ to $r_{T^\circ} = R_{273^\circ}/R_{0^\circ}$, the difference in the disturbing thermal energy is approx. eliminated, affords the possibility of establishing relations between the periodic system of the elements and the mechanism of conduction of the metals within the meaning of the type law. H. G. S.

MAGNETISM AND ELECTROMAGNETISM.

2188. Magnetic studies of solid solutions. II. The properties of quenched Cu-Fe alloys. F. BITTER, A. R. KAUFMANN, C. STARR AND S. T. PAN. *Phys. Rev.*, **60,** *pp.* 134–138, *July* 15, 1941. —The alloys of Cu and Fe which have been studied show unusual magnetic properties both in the saturation effects at low temperatures and in the apparent change in the magnetic moment of the dissolved Fe atoms over the range of temperatures from 14°K. to 1 300°K. Further research is required on other alloy systems containing transition elements dissolved in the noble metals in order to ascertain whether the phenomena are due to fundamental magnetic properties or due to the state of aggregation of the Fe atoms. [See Abstr. 252 (1940)]. AUTHORS.

2189. Alternating strain and magnetic properties. K. FINK AND H. LANGE. *Phys. Z.*, **42**, *pp.* 90–95, *April*, 1941. *In German.*—Experiments to investigate the change in the magnetic properties of ferro-magnetic materials with alternating strain are described. The present paper concerns the changes in magnetic induction due to amplitude of alternating strain, the dependence on frequency of load change being dealt with later. The testing machine with rotating C-steel test-pieces, the induction, energizing and de-energizing coils and the testing instruments, are briefly described. The experimental results, given in a series of curves, are discussed, and it is established that a far-reaching analogy exists between the mechanical alternating strain and the alternating magnetic field treatment of a ferromagnetic material. H. G. S.

2190. The effect of dislocations on magnetization near saturation. W. F. BROWN, JR. *Phys. Rev.*, **60**, *pp.* 139–147, *July* 15, 1941.—The effect of dislocations on the magnetization curve at high fields is calculated by direct use of dislocation theory. The deviation from saturation is assumed to be due to magnetostrictive forces, localized in the stress field about the dislocation rather than at the dislocation itself; their effect is more complicated than that of the simple line concentrations of force considered earlier [Abstr. 1659 (1940)]. Pairs of dislocations of opposite sign, separated by a short distance, contribute a term a/H to the deviation from saturation; in this respect they resemble line concentrations. Pairs separated by a long distance and surplus dislocations of one sign contribute a term b/H^2, with b theoretically not a constant but a logarithmically varying function of H. From data on the variation of the empirical a and b with plastic strain it is possible to calculate the density of dislocations and the block length if a value is assumed for the distance Y between the members of a dislocation pair. The orders of magnitude obtained agree with those obtained in the theory of hardening if Y is taken $\cong 2 \times 10^{-6}$ cm. It appears that all but about 1% of the dislocations are members of such pairs. AUTHOR.

2191. General classical theory of spinning particles in a Maxwell field. H. J. BHABHA AND H. C. CORBEN. *Proc. Roy. Soc. A*, **178**, *pp.* 273–314, *July* 31, 1941.—The particle is assumed to be a point, and its interaction with the field is described by a point charge g_1 and a point dipole g_2. The Maxwell equations are assumed to hold right up to the point representing the particle. Exact equations are then derived for the motion of the particle in a given external field, strictly consistent with the conservation of energy, momentum and angular momentum, and containing the effects of radiation reaction on the motion of the particle. It is shown that in the presence of a point dipole the energy tensor of the field can and must be re-defined so as to make the total energy finite. The mass, the angular momentum of the spin and the moment of inertia perpendicular to the spin axis, appear in the equations as arbitrary mechanical constants. Reasons are given for believing that for an elementary particle the last constant is zero, in agreement with relativistic quantum theory. In the general theory there is no relation between the electric and magnetic dipole moments of the particle and the state of its translational motion. A procedure is given for deriving from the general equations specialized equations consistent with the condition that the dipole is always a purely magnetic or electric one in the system in which the particle is instantaneously at rest. The radiation reaction terms are very much simpler in the former of these specialized cases than in the general case. The effect of radiation reaction is to make the scattering of light by a rotating dipole decrease inversely as the (frequency)^2 for h.f., just as for scattering by a point charge. AUTHORS.

2192. General classical theory of spinning particles in a meson field. H. J. BHABHA. *Proc. Roy. Soc. A*, **178**, *pp.* 314–350, *July* 31, 1941.—An exact classical theory of the motion of a point dipole in a meson field is given which takes into account the effects of the reaction of the emitted meson field. The meson field is characterized by a constant $\chi = \mu h$ of the dimensions of a reciprocal length, μ being the meson mass, and as $\chi \to 0$ the theory of this paper goes over continuously into the preceding theory [Abstr. 2191 (1941)]. The mass of the particle and the spin angular momentum are arbitrary mechanical constants. The field contributes a small finite addition to the mass, and a negative moment of inertia about an axis perpendicular to the spin axis. A cross-section is given for the scattering of *transversely* polarized neutral mesons by the rotation of the spin of the neutron or proton which should be valid up to energies of 10^9 eV. For low energies E it agrees completely with the old quantum cross-section, having a dependence on energy proportional to p^4/E^2 (p being the meson momentum). At higher energies it deviates completely from the quantum cross-section, which it supersedes by taking into account the effects of radiation reaction on the rotation of the spin. The cross-section is a max. at $E \sim 3{\cdot}5\mu$, its value at this point being 3×10^{-26} cm.^{2}, after which it decreases rapidly, becoming proportional to E^{-2} at high energies. Thus the quantum theory of the interaction of neutrons with mesons goes wrong for $E \geq 3\mu$. The scattering of longitudinally polarized mesons is due to the translational but not the rotational motion of the dipole and is at least 20 000 times smaller. With the assumption previously made by the present author, that the heavy particles may exist in states of any integral charge, and in particular that protons of charge $2e$ and $-e$ may occur in nature, the above results can be applied to *charged* mesons. Thus transversely polarized mesons should undergo a very big scattering and consequent absorption at energies near $3{\cdot}5\mu$. Hence the energy spectrum of transversely polarized mesons should fall off rapidly for energies below about 3μ. Scattering plays a relatively unimportant part in the absorption of longitudinally polarized mesons, and they are therefore much more penetrating. The theory does *not* lead to Heisenberg explosions and multiple processes. AUTHOR.

2193. Ionic diamagnetic susceptibility and diamagnetic correcting constants. V. C. G. TREW. *Trans. Faraday Soc.*, **37**, *pp.* 476–492, *Sept.*, 1941. —Ionic diamagnetic susceptibility values for simple univalent ions of Periodic Table Groups I and VII have been calculated. The relationship between theoretical and experimental ionic susceptibilities for ions of related series has been considered graphically, showing that theoretical values follow substantially the same general form as experimental ones, but the relationship is not a linear one. The deviations between theoretical and experimental values are discussed and it is shown graphically that, contrary to some opinions, such deviation is quite systematic. AUTHOR.

2194. Biot-Savart law and Newton's third law of motion. S. B. L. MATHUR. *Phil. Mag.*, **32**, *pp.* 171–176, *Aug.*, 1941.—Newton's third law of motion is not generally valid for the mutual forces between current elements, a fact which frequently leads to wrong results when Newton's law is applied to electrodynamical problems. Thus the force between 2 moving point charges is wrongly obtained. In Dunton's circuit-breaker experimental results differ greatly from theory because in the latter Newton's law has been assumed to apply. The former assumption, that the Biot-Savart law is incorrect, is therefore unfounded. A. J. M.

See also Abstracts 1940, 2151.

MEDICAL RADIOLOGY AND ELECTROLOGY.

2195. Comparison of certain aspects of 200 and 400 kV radiation. C. C. MCCLURE. *Amer. J. Roentgenol. & Radium Ther.*, **45**, *pp.* 909–914, *June*, 1941.—Data with respect to depth dosage have usually been obtained with flat metallic filters. The author has adopted a method in which a cylindrical filter is placed round the ionization chamber thimble itself. Such filter thimbles are made of copper and the sweated joint is placed perpendicular to the radiation so as not to affect the results. Measurements were made at 200 and 400 kV excitation and comparison of the results gives nearly identical curves in which the thimble curve lies above the flat-filter curve at approx. const. distance, the difference being due to the wall effect, i.e. the greater effect of scattering by the thimbles. The results show that at the depth of 10 cm. paraffin wax there is a greater proportion of soft radiation at 400 than at 200 kV excitation, although the radiation is still generally more penetrating. B. J. L.

2196. Method of simplified depth dosage calculation for clinical purposes. G. E. ROTH. *Amer. J. Roentgenol. & Radium Ther.*, **45**, *pp.* 915–921, *June*, 1941.—Variation of methods of measuring skin and depth X-ray doses has led to discrepancies of results, particularly with respect to earlier measurements. Skin dosage can be conveniently read graphically for treatment purposes but similar methods for depth dosage are complicated by many factors, 7 of which have been considered by Packard for graphical determinations. The present author describes a simplified method which eliminates 2 of these factors and combines 3 factors. The method is illustrated by graphical examples based on data obtained by various investigators. The view is expressed that more accuracy can be obtained by use of reliable data so available than by actual direct measurements in clinical practice upon a patient or phantoms. B. J. L.

***2197. Electrical bombardment of biological materials. II. Electron tube for the production of homogeneous beams of cathode rays from 10 to 100 kV.** O. MORNINGSTAR, R. D. EVANS AND C. P. HASKINS. *Rev. Sci. Instrum.*, **12**, *pp.* 358–362, *July*, 1941.—An apparatus is described for irradiation of biological and chemical materials in vacuum with electron beams of intensities varying between 10^{-6} and 10^{-10} coulomb/cm.^{2} and of energies ranging between 10 and 100 kV. The beam can be easily adjusted and scanned for homogeneity. Through an arrangement of stops a large number of targets can be conveniently irradiated in a relatively short period. [See Abstr. 1834 (1939)]. AUTHORS.